COMPARATIVE STUDIES IN THE POLYPORACEAE

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The subclass *Basidiomycetes* of the class *Fungi* contains a natural group of plants sharply separated from related groups in that the hymenium (basidia, paraphyses, etc.) forms the lining of hollow tubes on the ventral surface of the fruit body. This group of plants constitutes the tribe *Polyporeae*. It is divided into two families, the *Boletaceae* and the *Polyporaceae*. The *Boletaceae* are separated from the *Polyporaceae* in that they are fleshy and soon decay and the tubes are easily separated from the pileus, while the *Polyporaceae* vary in texture from coriaceous to hard and woody, and the tubes are inseparable from the pileus. These characters are susceptible of some variation, as there are a very few fleshy species in the latter family, and in two or three cases the hymenium is waxy and the tubes separable. In this article we are concerned only with the *Polyporaceae*.

Historical

Accurate knowledge of the classification of the *Polyporeae* dates back only to the last few years of the eighteenth or the beginning of the nineteenth century. The first attempt worthy of consideration was that of Persoon in 1801, although we still have occasion to refer to articles by earlier writers, especially Bulliard (Herbier de la France, 1780–1793), Schaeffer (Fung. Bav. 1780), and Sowerby (Eng. Fung. 1797–1809). These three, while contributing considerable in the way of illustrations of the species known at that time, knew very little about the correct classification of the species they illustrated. The binomial method of naming species had come into general use following its introduction by Linnaeus (Species Plantarum) in 1753, and many new species were described in the succeeding years, but the descriptions were inadequate and

the type specimens not preserved, so that it is impossible to tell to what plants the descriptions refer.

By the beginning of the nineteenth century those interested in this line of study had begun to feel the need of permanent herbaria containing specimens of all the species described. The appreciation of this need augmented the demand for a more systematic and a more natural arrangement of the genera and species of fungi.

It thus came about that while Linnaeus in 1753 had listed but one genus, *Boletus,* and 12 species of pore fungi (*Boletaceae* and *Polyporaceae*), the number of genera had increased to 3 and the number of species to 93 when Persoon published his 'Synopsis Fungorum,' in 1801. This was followed by the work of Albertini and Schweinitz (Conspectus Fungorum) in 1805, which was modeled after the work of Persoon and contributes nothing to the systematic arrangement of the *Polyporeae.* It must not be supposed, however, that there was any extraordinary change from the incomplete descriptions of the earlier writers to a more or less perfect standard of description that should include all the facts necessary for the identification of the species. The descriptions in Persoon's 'Synopsis' were still far from what could be desired, and it is only where these are supplemented by herbarium specimens or by accurate illustrations or by both that the species can be identified beyond all doubt. But the fact remains that the beginning of the nineteenth century witnessed a growing inclination on the part of mycological systematists toward a form of record for the species that would be more concrete in its conception and thus give an added impetus to the study of the fungi.

Among the vast array of mycologists produced in the nineteenth century by far the most prominent was Elias Fries. His first work of importance was the 'Systema Mycologicum,' published in 1821–1832, in which the known fungi were marshalled in order. To the genera of the *Polyporeae* listed by Persoon he added the genus *Polyporus* (first proposed by Micheli in the eighteenth century) and thus made the first attempt to separate the *Boletaceae* from the *Polyporaceae.*

The genera treated by him contained 164 species in all, of which probably two-thirds were in the single genus *Polyporus*. This genus was divided into 3 sections, *Favolus, Microporus,* and *Polystictus,* the first named being later raised to generic rank. The section *Microporus* contained by far the largest number of species. It was divided into 5 subgenera: *Mesopus, Pleuropus, Merisma, Apus,* and *Resupinatus*. This arrangement was continued in his 'Epicrisis Systema Mycologicum,' published in 1836–38. In the meanwhile the genera *Trametes, Cyclomyces, Hexagona, Favolus, Laschia,* and *Porothelium* had been carved from the old genus *Polyporus,* and the number of species described had increased to 361 (entirely exclusive of the genus *Boletus*). Of these, 280 were included in the genus *Polyporus*. The same disposition of the pore fungi was followed by Fries in his last publication, 'Hymenomycetes Europaei,' in 1874, and, indeed, that system has either been followed in its entirety since or has served as a foundation for all other systems of classification that have been proposed from time to time by others.

Correlated with the increase in the number of described species there is manifest a tendency on the part of some later writers toward a change in the conception of what should constitute a genus. There has been a tendency away from the old idea of large genera containing a heterogeneous collection of species, and toward the breaking up of genera into smaller units consisting of closely related individuals. This tendency finds its best expression in the work of Karsten, Quelet, and Murrill, each of whom has published papers dealing with the classification of the *Polyporaceae*.

IMPORTANT MICROSCOPIC CHARACTERS USED BY EARLIER WORKERS

Having glanced at the beginnings of the various classifications that have been proposed, we may now turn our attention to an analysis of the characters used in separating genera and species. For the most part the generic characters were macroscopic ones, such as presence or absence of a stipe, consistency of the sporophore, nature of the hymenium, etc.,—characters that arrested the attention of the collector without

recourse to the microscope, for the microscope was unknown when the foundations of this study were laid. In the separation of species other macroscopic characters of minor importance were used. Color, pubescence, habitat, form, size, etc., were characters that were largely drawn upon in fixing the limits of species.

It was unfortunate, however, that though the characters named are the most conspicuous ones, yet they are more subject to modification and variation than are certain internal characters that require the use of the microscope for their detection. Perhaps the desideratum in systematic botany would be a classification in which genera are well defined and sharply separated from each other by gross morphological characters, and in which the microscope would be necessary only in determining specific characters. Perhaps this demand is more nearly filled in the family *Agaricaceae* than in any other group of the fungi. There the genera are divided into sections on the color of the spores, and the genera in these sections are more or less well differentiated on gross morphological characters.

In those groups of the fungi that have been most carefully studied, e. g., the *Myxomycetes,* considerable attention has been paid to the minute anatomical structure of the plant. Spore markings that are scarcely visible, except with an oil-immersion lens, have been used as points of separation in closely related forms, and in certain of the *Discomycetes* the spore markings and the nature of the paraphyses have been largely drawn upon to furnish specific characters. Durand[1] has gone somewhat farther, and in his studies in the fleshy *Pezizineae* has taken into account the structure of the apothecium in fixing the limits of the families. Burt[2] has recently set new limits to some of the genera of the *Thelephoraceae,* in keeping with their inner anatomical structure. In the *Polyporaceae,* Miss Ames[3] has recently attempted to outline a scheme of classification of the genera based largely on the structure of the sporophores, but only a few forms

[1] Bul. Tor. Bot. Club 27: 463–495. 1900.
[2] Ann. Mo. Bot. Gard. 1: 195–196. 1914.
[3] Ann. Myc. 11: 211–253. 1913.

were investigated and the results not as satisfactory as could be desired.

It is a significant fact, however, that no attempt has been made to classify the *Polyporaceae* on the basis of spore or other hymenial characters, although it is recognized that, outside of the algae, the organs concerned in reproduction are usually subject to less variation than are external morphological characters. That no such attempt has been made is due to two causes: first, the dislike on the part of students of the careful and painstaking observations that must often be made to determine those characters; and second, to the widespread belief that the pore fungi are spore-bearing only for a short interval of time during the year, and that they must be examined at the right moment or the spores will have disappeared. When it has been shown that the second objection is invalid and that hymenial characters are usually not hard to make out, the first objection will largely disappear.

In the course of the last year the writer has spent a considerable portion of his time in searching for these characters, not only in the *Polyporaceae* but in other related families as well. The methods employed are given on a following page, and suffice it to say here that probably 75 per cent of the collections examined contained spores, and a large percentage afforded other microscopic characters that played a considerable part in distinguishing one species from another. The characters that may be obtained by the use of the microscope are here enumerated and some indication given as to their possible value.

Discussion of Microscopic Characters Now Available for Use as Generic and Specific Characters

The characters that may be obtained by the methods outlined on a following page are as follows: spore characters, presence or absence of cystidia, setae and other sterile organs in the hymenium, basidial characters, hyphal characters, and the presence or absence of sterile structures in the subhymenial tissue.

Spore characters.—Spore characters are probably worthy of a great deal more consideration than they have yet received in the greater part of the mycological work that has been done up to the present time. As previously stated, in the *Agaricaceae* the primary divisions of the family are made on the basis of spore colors. This distinction was made as early as 1821 by Fries in his 'Systema Mycologicum.' The fact that this character was so early recognized was not because spores are more abundant or their colors more striking in the gill fungi, but because the period of spore production more closely coincides with the period of maximum development of the plants. Unfavorable conditions, i. e., drought, superabundance of moisture, cold, etc., result in the disorganization of the tissue in a fleshy fungus, and consequently the duration of the period of spore liberation is permanently shortened. In the coriaceous or woody forms these same conditions result only in a temporary suspension of the act of spore liberation and with the return of normal conditions the suspended function again becomes active. In this way the period during which spores are present in the hymenium of a pore fungus is greatly lengthened, and it is safe to assume that the number of mature spores present at a given time in the hymenium of one of the more durable pore fungi is less than the number of mature spores on an equal hymenial surface of a gill fungus. Contrary to the condition in the *Agaricaceae,* the introduction of spore colors as generic characteristics would mean an entire revision of all the genera, and it may well be doubted whether the advantage obtained from such a limitation of genera would compensate for the confusion that would be sure to arise. On this basis, however, the species could easily be grouped into sections under the genera, but even were that done the white-spored species so far outnumber those with colored spores that the adoption of the idea would delimit only a small group of species that perhaps could be better separated in other ways.

Very little exact evidence bearing on the variation in size in the spores of a given species is obtainable. The work of

Falck[1] showed that the mature spores of certain species of *Lenzites* were very constant in the length of their short axes, the variations being only a fraction of one micron, while the length of the long axis varied considerably, although in that case the variation rarely went beyond 3 μ in different spores from different fruit bodies. Cotton[2] investigated variations in the spores of *Stropharia semiglobata* and found that when the pileus was cut from the stem and a series of spore prints obtained from the former, the spores shed during the first hour measured 18×10 μ, while those shed during the twenty-third hour measured 15×9 μ, and those shed during the eighty-third hour measured only 12×7 μ. The diminution in size was ascribed to the artificial conditions, i. e., the pileus being severed from the stipe, under which the spores were produced. Experiments carried on with sporophores collected and placed in large test-tubes and supplied with water, showed that the spores shed the first day did not differ in size from those shed during the fifth or sixth day. The first experiment suggests the possibility that in plants growing in nature the size of the spores might be reduced if the fungus was growing on a substratum in which the required amount of food substances was not present. No comparative studies along this line have yet been reported and the question of the amount of variation in size of spores is still an open one. However, spore measurements have been very successfully used in separating species of fungi and no doubt the limit of their usefulness has not yet been reached in systematic mycology.

Inaccurate spore measurements may creep into the literature through a misdetermination of species quite as easily as species may be misdetermined because of inaccurate spore measurements. The former condition is especially liable to be pronounced in the literature of a fungous flora as little known as is that of this country, and where species are not determined on microscopic characters, but these same characters are entered in the literature when the species is re-

[1] Moeller's Hausschwamm-forschungen, Heft 3, pp. 79–96. 1909.
[2] Trans. Brit. Myc. Soc. 4: 298–300. 1914.

corded. This latter procedure is entirely commendable, but it has been so much abused that the spore characters carried in the literature are far from being reliable in a large number of cases. However, allowances must be made for some variation in measurement by different individuals as no two persons will report exactly the same measurements for one species.

The shape of the spores is probably subject to somewhat less variation with age than is the size. Spores begin to take their characteristic shape while they are yet comparatively immature and from seeing such a spore one can judge of its mature form more accurately than of its mature size. Often the spores of two or more species are so similar in shape that it is perhaps best not to try to distinguish between them, although the distinction may be perfectly apparent to one who has before him the spores of all the species in question. The terms used to describe spore forms are not as rigidly defined as we could wish, and it does not add to the clearness of distinction between two species to describe the spores of one as "elongate-ellipsoid" and of the other as "narrowly fusoid" and expect the users of the manual to distinguish the species on that basis. There are many cases, however, where the form of the spores may be used to good advantage.

Spore markings are so universally absent in the *Polyporaceae* that the subject requires very little comment here. There are probably not more than a dozen species that are characterized in this way and they are so widely separated that the character is given an added value. In some groups of the fungi, especially among the *Ascomycetes,* not only the presence or absence of markings on the spore wall but also the nature of these markings is taken into account.

Cystidia.—Cystidia may be defined as more or less conspicuous sterile organs found either in the hymenium or in the subhymenial tissue of various basidiomycetous fungi. They are usually unicellular and they may be smooth or they may have a more or less incrusted surface, the incrusting substance probably always being calcium oxalate. The name "setae" has been given to these bodies when they are colored

(usually brown) and sharp-pointed, and that distinction is maintained in this paper, although there may be some doubt as to the advantage that accrues from its use. The presence or absence of setae has been made a generic character in some groups of the *Basidiomycetes,* and even in the *Polyporaceae* the genus *Mucronoporus* was founded by Ellis and Everhart on the presence of the setae in the hymenium. The genus probably has not received the acceptance that it has deserved at the hands of mycologists. It is difficult to say at times whether a given structure should be designated as a cystidium or not, but the writer is of the opinion that the term should be used in its broadest sense, except that it should not be applied to those structures usually referred to as paraphyses. These latter can usually be distinguished by the frequency of their occurrence as they usually alternate with the basidia, while cystidia or setae are scattered irregularly through the hymenium. In by far the largest number of cases the cystidia are very conspicuous on account of their size, coloration, incrustation, or other characters. In a few cases the presence or absence of setae is a variable character, in some specimens being abundant and in others very scarce. In such cases the writer has found it advisable to make longitudinal sections of the tubes, as the setae are sometimes more abundant in one part of the tubes than in another. A cross-section of the tubes of *Fomes igniarius* will sometimes fail to show a single seta, but in only one specimen has the writer failed to locate them in longitudinal sections from the hymenium of the same plant. They are also almost entirely lacking in some specimens of *Polyporus dryophilus.*

Basidia.—It is very seldom that the basidia offer characters that can be used in separating species. They are almost universally 4-spored in the *Polyporaceae* and in those few species where 2- and 3-spored basidia do occur there are always a goodly number of 4-spored ones present also. In a very few cases the basidia are conspicuous on account of their large size. This is true of *Trametes Peckii* where they are 8–10 μ broad, while usually they vary from 3 to 6 μ broad.

Hyphal characters.—The characters of the hyphae that make up the subhymenial tissue and the tissue of the trama of the pileus have never been used in the classification of the *Polyporaceae.* While the size of the hyphae may depend to a considerable degree on the food supply of the plant, yet in examining a large number of species the writer has found that some are characterized by hyphae two to three times as large as in most species. These cases have been thoroughly investigated as far as herbarium material would permit and as all specimens have showed the character about equally well, it has been taken as a means of identifying the species in which it has occurred. The writer knows of no factor or combination of factors that would be operative on a large number of individuals from widely separated localities and in the case of but a limited number of species. If it be dependent on nutrition, then the species possessing this character are so constantly associated with that kind of nutrition that the character is as constant a one as can be obtained. The same is true of the unbranched hyphae of the context of *Polyporus albellus.*

Incrustation of the hyphae has never been observed in the pileate *Polyporaceae,* though it is a well-marked character in the species of certain groups of resupinate fungi.

METHODS EMPLOYED

A few words may not be amiss here concerning the methods employed by the writer in obtaining these microscopic characters. In general the method is that already described in a previous number of this journal.[1]

Obtaining spore prints.—In the case of fresh specimens just brought into the laboratory from the field, spore prints are very easily obtained by placing the specimens on a glass slide in such a manner that the tubes are in a perpendicular position so that the spores do not lodge on the sides of the tubes when they are liberated from the basidia. The slide with the fungus in position should be either wrapped in waxed paper or left over night or for several hours in the collecting

[1] Burt, E. A. *loc. cit.*

basket or other receptacle in which a fairly high humidity will be maintained, so that the liberation of the spores will not be prematurely stopped by the drying-out of the tissues of the fungus. If the specimens are dry when brought into the laboratory they may be moistened thoroughly with water and then treated as described above. One unaccustomed to this procedure will be surprised to find how large a percentage of the collections so treated will produce a good spore print. Specimens collected on the warm days that frequently come in January and February have often been treated in the above manner with gratifying and surprising results. When desiccation takes place by exposure to the air the vitality of many species is not destroyed. Buller[1] was able to restore normal vitality to such plants by placing wet cotton-wool on their upper surfaces. He was even able to revive the fruit bodies of *Daedalea unicolor* after they had been exposed to ordinary air at room temperatures for eight years and three months, and of *Schizophyllum commune* after an exposure of six years and three months. In most species, e. g., *Polyporus versicolor, P. hirsutus,* and *Lenzites betulina* the vitality was retained for a period of but two to three years.

Sectional preparations.—In case one is working with material that has been in the herbarium for several years the above method will not answer. Neither does it furnish any evidence as to the other microscopic characters of the plants. One must then resort to sectional preparations. These are cut free-hand with a very sharp sectioning razor. Free-hand sections are quickly made and the results from them are usually better than from microtome sections. It is impossible for the spores to retain their position on the basidia when subjected to the different processes involved in preparing material for microtome sectioning. The first requisite in successful free-hand sectioning is material in good condition; the second is a very sharp razor (preferably flooded with alcohol); the third is some little skill and experience. The hymenium of the specimen is first moistened with alcohol, then with water,

[1] Researches on fungi, pp. 105–111. 1909; and in Trans. Brit. Myc. Soc. 4: 106–112. 1913.

and a piece about 2 mm. square on the hymenial surface is cut out with a scalpel. If material is abundant the process may be reversed and a larger piece than needed may be cut out with the scalpel, trimmed to the requisite size, immersed in 95 per cent alcohol for a few seconds and then transferred to water. In the writer's experience the latter method is the more preferable and has probably been the one most used. The material does not soften while in alcohol, but that reagent is used only to facilitate the absorption of water by the tissue. Any rigidity that may be imparted to the tissue by the alcohol is probably overcome when the material is transferred to water. In some cases when this transfer is made the tissue either becomes very soft or very friable so that no razor, however keen, will cut a clean section through it. It is here that the latter method obtains preference over the former, for after some experience one can judge of the probable effect the water will have and by shortening the period that the material remains in the water the tissue is in better condition for sectioning.

The most instructive preparations are often those containing both longitudinal and cross-sections of the tubes. Such sections are easily obtained in one mount by cutting out the piece of material somewhat longer in one direction than stated above—say about 2×4 mm. on the surface. Several longitudinal sections may be cut from this and the position of the remaining bit of tissue so changed that cross-sections may be obtained.

For sectioning, the tissue is placed in the proper position in a piece of pith and as the sections are cut they may either be transferred directly to the slide by means of a camel's-hair brush dipped in alcohol, or they may be allowed to accumulate in the alcohol on the razor and then flooded off into a watch-glass containing alcohol. By the last method one can pick out with more accuracy the thinner sections by observing them under the lens of a low-power dissecting microscope. The writer has found it to be sufficient in most cases to transfer the sections directly to the slide, disregarding the thicker sections that are cut, or brushing them off the edge of the

razor with an outward stroke of the finger. The sections are placed in a drop of 7 per cent KOH solution on the slide. This immediately expands the hyphae of the tissue to their normal size. The KOH solution is then drained off and a drop of stain added.

Staining and mounting.—I have tested a considerable number of the more common stains and so far I have failed to find one that gives universally good results if the sections are to be made into permanent mounts. For temporary mounts there is nothing superior to a 1 per cent water solution of eosin, but when sections so stained are mounted in glycerin the color soon completely disappears. The same strength solution of alcohol eosin (in 95 per cent alcohol) often gave a good permanent stain but quite as often it, too, faded out in the course of several weeks, and when used it gives a precipitate that must be washed off with water before the cover glass is applied. Why this stain should remain permanent in some cases and not in others is a question that has not been answered. It may be due to the KOH that remains on the slide and in the sections, but flooding the sections with water after draining off the KOH solution did not seem to have any beneficial effect. Different strengths of alcohol were used in preparing the stain, but with alcohols weaker than 95 per cent the stain disappeared even more quickly and the precipitation obtained was so great that such stains were of no value. From the facts observed it seems more reasonable to suppose that the difference may be in the tissue of the fungus rather than in the stain or the glycerin. A solution containing equal parts of a 1 per cent water solution and a 1 per cent alcoholic solution of eosin gave no better results.

Magdala red, Congo red, neutral red, acid fuchsin, methylen blue, and saffranin T were used, and of these, only the last one gave a permanent stain and it has been used in a large part of the work. It is a rapid stain, though probably not quite so rapid as alcoholic eosin, and it is well to leave the stain on the sections for about one minute. A 1 per cent alcoholic solution was used, the stain being dissolved in 95 per cent alcohol. When a drop of this stain is added and drained

off, the sections must not be allowed to become dry or an orange precipitate is obtained that necessitates the addition of alcohol to dissolve it. This also dissolves the stain from the tissues and the sections must be restained. This precipitate is not formed if a little water is added to the stain after it is made up. This stain imparts a uniform dull red color to the tissue but the color brightens when glycerin is drawn under the cover glass. Since it is not a differential stain its use is not advised where only temporary mounts are desired. It gives best results with very thin sections or with sections in which the hyphae are loosely arranged.

After the cover glass is applied the sections are ready to be examined under the microscope, but if the saffranin T stain is used, it is better to place a drop of glycerin at one side of the cover glass, at the same time drawing off some of the surplus water from the opposite side by means of filter paper. Several slides of each species are retained and mounted in 66 per cent glycerin. After a week or more all traces of the glycerin are removed from near the outer edge of the cover glass by means of a soft cloth dipped in 95 per cent alcohol. The slides are then ringed with some suitable cement—gold-size being most often used—labeled, and filed away in order. It will usually facilitate subsequent examination of the slides if the spore characters for each species are written on a slip of gummed paper and glued to one end of the slide.

It is sometimes quite impossible to find spores in the sections treated in the manner outlined above, since they are often easily removed from the sterigmata and washed away before the cover glass is applied. To overcome this difficulty the writer sometimes finds it advisable to distribute between two slides the sections obtained, one slide to be treated as outlined above, the other to be mounted for temporary observation only. This last one should be stained with a water solution of 1 per cent eosin, a drop of the solution being added to the drop of KOH containing the sections. Sometimes the staining is unnecessary, especially if one is dealing with species which have colored hyphae and colored spores. A

preparation made in this manner will often show spores when other methods of demonstrating them have failed.

Even with the most careful manipulation one will sometimes fail to find the spores, and, indeed, some species seem to be almost always sterile. In the case of *Fomes fomentarius* I cut sections of all the specimens available, and only when as a last resort, I sectioned a small and very unpromising specimen did I find the spores. I have been able to locate them in but one of the few specimens of *Polyporus graveolens* that were available for examination.

As stated above, the literature dealing with American *Polyporaceae* contains many inaccurate observations concerning spores. This is due mostly to a lack of care in making sure that a given body in the hymenium is really the spore of the fungus in question. The writer is of the opinion that spores should not be recorded for a collection unless they are obtained from a spore print or are seen attached to basidia. The spores found on basidia are usually somewhat immature, at least as regards size, but from their shape one can judge whether the spores found free-floating in the mount have any relation to the species under consideration. Where such free spores alone are present there is always the possibility that they belong to some other fungus and they should not be taken into consideration unless present in large numbers. One must also guard against the fact that the cut ends of hyphae may be in such a position as to appear globose in form and such may be mistaken for spores.

Examining the context hyphae.—In obtaining the characters of the hyphae of the context a bit of tissue is picked out with the forceps and mounted on a slide in a drop of KOH solution. In the case of some of the species of the genus *Fomes* where the context is hard and woody, it is usually better to boil a bit of the context in a KOH solution for a few minutes. In this way the tissue is softened and when teased apart on the slide with needles, a cover glass added, and pressure applied, the hyphae will generally separate out so that their characters may be obtained. In all cases the

hyphal measurements given are for the hyphae in the context of the plant and not for those in the subhymenial tissue.

STATEMENT OF PROBLEM

The writer presents in this paper the results obtained by carefully investigating some of the more common species of pore fungi, using the methods outlined on the preceding pages. There are certain groups of species in the *Polyporaceae* that are very much in need of just such treatment, and it is to these groups that the writer has turned his attention. The groups consist of closely related species that have been separated heretofore largely on external characters and in a great many cases the results have only led to confusion. The problem, as the writer saw it, was one involving a contribution toward a more exact characterization of these species and their separation, wherever possible or feasible, on some constant internal microscopic character. Some species are well enough marked by external characters so that such distinctions should be used only as supplementary characters, while in other cases the characters obtained by this study should displace those hitherto used.

The results obtained were not as gratifying as was expected when the work was undertaken. Only a small beginning has been made, for it is a laborious task involving the cutting and examination of many sections for each species in order to be sure that the characters shown by the first sections are constant for all collections of the same species. The work should be carried on although several years would be required for its completion. Permanent mounts of the sections have been made for each species and these are available for future reference. Criticisms and suggestions, both of methods employed and results obtained, are invited and will be given careful consideration.

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Polyporus abietinus Dicks. ex Fries and P. pargamenus Fries

P. abietinus was first described by Dickson,[1] in 1793, and appears to be almost cosmopolitan in its distribution. In the United States it is found wherever coniferous forests abound, from Canada to the Gulf of Mexico, and from the Atlantic to the Pacific Ocean. It is never found on the wood of deciduous trees, and as will be pointed out later, this fact affords almost the only constant character by means of which it can be separated from its near relative, *P. pargamenus.*

P. pargamenus was described by Fries,[2] in 1838, from plants collected on pine wood in Arctic America by the Franklin Expedition. The plant has not been reported from the western coast of the United States, but has been found in practically every state east of the Mississippi River, ranging west as far as Wisconsin, Kansas, Arkansas, and Colorado. It is also found in Europe. Most of the collections in this country under the name *P. lacerâtus* Berk., *P. xalapensis* Berk., or *P. ilicincola* Berk. and Curt., belong to this species. An examination of *P. pseudopargamenus,* as distributed by de-Thuemen,[3] shows it to be identical with *P. pargamenus.* The writer has not seen authentic specimens of the other species named above, but they are given as synonyms by Murrill.

By some writers the two species have been confused, due to the fact that the type specimens of *P. pargamenus* were reported as growing on the wood of coniferous trees, while in the United States the plant that has gone under the name *P. pargamenus* is confined entirely to the wood of deciduous trees. This has led some authors to regard the original *P.*

[1] Pl. Crypt. Brit. 3: p. 21. 1793.
[2] Epicr. Syst. Myc. p. 480. 1838.
[3] Myc. Univ. 1102.

pargamenus as probably a synonym for *P. abietinus*. In that event, the species on the wood of deciduous trees would have to be given another name. This point can be settled only by a study of the type specimens of *P. pargamenus,* if they are still preserved. Nearly all the exsiccati material has been distributed under the name *P. pargamenus,* and the plant is so common and the name so well established that it is the writer's opinion it should not be changed without recourse to the types.

The two species under discussion are very closely related and they are connected by intermediate forms to such an extent that it is difficult to refer some collections to their proper species. However, the usual form of the fructification is distinct enough. *P. abietinus* is usually much smaller, is frequently effused-reflexed with a narrow and often laterally continuous pileus, rarely more than 2 cm. in length, and the tubes sometimes break up into lamellae-like plates—a condition I have never found in *P. pargamenus.* That species often grows much larger than *P. abietinus,* sometimes attaining a length of 6–7 cm., and is often fan-shaped or cuneate in outline and attached by a narrow, attenuate, sometimes stem-like base, so that the form and size of the fruiting body will usually separate it from *P. abietinus.* The color, zonation, and pubescence of the pileus is similar in both species, though the pubescence is often inclined to be strigose in the latter plant and more velvety in the former. Both species often have a violaceous or lavender tint to the hymenium or on the margin of the pileus.

The microscopic appearance of the hymenium of the two species does not furnish additional characters for their separation. The spores are similar in size and shape, being cylindric or sometimes allantoid, hyaline, smooth, and measuring 5–7 $\times$ 1.5–2.5 μ (not globose, 4.5–5.5 μ as stated by Murrill). Murrill states that no cystidia are present in the hymenium of *P. abietinus* and to the writer's knowledge their presence has never been recorded. I have examined several collections of both *P. abietinus* and *P. pargamenus* and I find that the plants vary as regards this character. I am of the opinion that cystidia are probably always present, but at times are so rare

or so inconspicuous that close observation is necessary to detect them and I have often examined whole sections without being able to locate them. A similar section taken elsewhere in the hymenium may show an abundance of them. The accompanying illustrations (figs. 1 and 2) show the different forms they may assume, but perhaps the most common form is as shown in *a* of fig. 1. They are often scarcely larger in size than the basidia, but are different in shape, usually with the appearance of slender pegs tapering to a rather blunt point. Rarely they are somewhat fusiform in shape and reach a length of 20 μ and a thickness of 6 μ. These sizes are unusual, however. They are colorless or almost so, sometimes scarcely extending beyond the basidia, but sometimes projecting enough that one can easily pick them out with the low power of the microscope. They are usually unincrusted, but sometimes their tips are somewhat capitate with small crystals (see fig. 2). They are then much more conspicuous, and in some collections this appears to be the predominating condition.

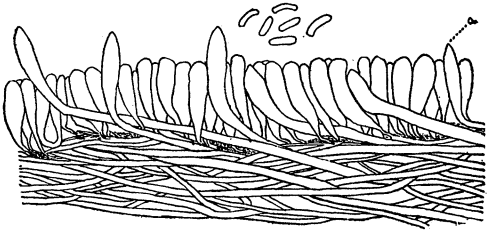


Fig. 1. Section of the hymenium of *P. abietinus* showing cystidia and spores.

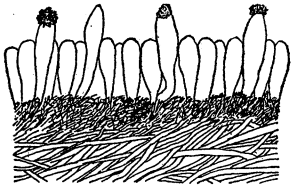


Fig. 2. Section of the hymenium of *P. abietinus* showing cystidia incrusted at the apex.

Before the writer had seen this more conspicuous type it was thought these sterile, inconspicuous structures might be basidia that had discharged their spores and had thus been rendered hyaline, as it is frequently found in other species that the mature spore-bearing basidia project somewhat beyond those that have not reached maturity. The shape of these bodies and the fact that they often assume a capitate apex, as do cystidia of many other species, make this view untenable. If more proof were needed it might be pointed out that these bodies are present in young specimens and in

the growing margins of mature specimens where it is evident that no mature basidia have yet been formed.

Neither can these structures be regarded as paraphyses that have become elongated and, therefore, more conspicuous. While there may be no ground for the belief that paraphyses can not assume such a form, yet there is no evidence to indicate that conspicuous sterile structures ever have arisen in such a manner. Moreover, the distribution of these structures under consideration makes impossible any such idea, as they are scattered promiscuously and do not alternate with the basidia.

These two species then are to be distinguished only by their habitat, and the size and shape of the pileus. In my own collecting experience the former character alone is enough to separate them, but when once the two plants are learned, the matter of form and size will usually be sufficient for the identification of the specimens, even if the habitat be unknown.

As stated above, the hymenium of *P. abietinus* may at times be lamellate. This statement is made only after a careful study of the facts in the case. They are as follows: There is a plant with apparently the same distribution as *P. abietinus,* in which the hymenium is entirely lamellate. No exactly intermediate conditions have ever been seen by the writer, though he has collected both forms in Colorado. In all other characters the two plants are precisely similar. The host is always the wood of coniferous trees; the pubescence and coloration of the pileus is the same; the spores and cystidia are similar; and the hymenium often has the violaceous tint characteristic of *P. abietinus. Irpex fuscoviolaceus* is in all probability only another form of the same plant, although I have never seen specimens of that species with the well-marked lamellate hymenium of this form. The illustration (pl. 23 fig. 1) is from specimens communicated by Prof. C. R. Orton, of State College, Pennsylvania. He writes that the rot produced by this fungus is almost identical with the one produced by *P. abietinus.* Patouillard[1] represents the cystidia of *Irpex*

[1] Hym. Eur. *pl. 3. f. 23.* 1887.

fuscoviolaceus as incrusted at the apex in the same manner as shown in the accompanying illustration of *P. abietinus*. I have also found this condition to be predominant in the lamellate form of our species.

The following comparative synopsis of the two species discussed in this section is appended here:

1. Polyporus abietinus Dicks. ex. Fries.

Plate 23, figs. 1, 2.

Pileus coriaceous, *sessile or effused-reflexed,* 0.5–5 × 0.5–5 × 0.1–0.2 cm., white, cinereous, or blackish with age, villous, zonate; context not more than 1 mm. thick; tubes not more than 3 mm. long, the mouths white, bay, or violaceous, averaging 2–3 to a mm. in poroid forms, *but sometimes entirely lamellate;* spores cylindric or allantoid, hyaline, 5–7 × 1.5–2.5 μ; cystidia present or inconspicuous, hyaline, rarely incrusted at the apex, 3–6 μ in diameter, projecting 5–15 μ; hyphae of context hyaline, 3–4 μ in diameter.

On wood of *coniferous* trees, especially of *Pinus*.

Illustrations: Dicks. Pl. Crypt. Brit. **3**: *pl. 9. f. 9.*—Fl. Dan. *pl. 1298, 2079. f. 2.*—Gill. Champ. Fr. *pl. 463.*—Swant. Brit. Fung. *pl. 33. f. 2–3.*

Specimens examined: Barth. Fung. Col. 3108.—Cooke, Brit. Fung. 512, 605.—Thuem. Myc. Univ. 6, 706.—Ell. N. Am. Fung. 8.—Ell. & Ev. Fung. Col. 303.—Krieg. Fung. Sax. 1205.—Rab.-Wint. Fung. Eur. 3235 (as *Irpex fuscoviolaceus*).—Rav. Fung. Am. 422; Fung. Car. I, 12.—Shear, N. Y. Fung. 307.—Mo. Bot. Gard. Herb. 4726, 4727, 4728 (Newfoundland), 3854, 4213 (New York), 4214 (Labrador), 4220 (Alabama), 4074 (Colorado).—Burt Herb. (collections from Vermont and Washington).—Overholts Herb. 2001 (Colorado), 2465 (Pennsylvania), 2472 (Maine).

2. Polyporus pargamenus Fries. Plate 23, fig. 9.

Pileus coriaceous, *sessile, often narrowed at the base,* 1–7 × 1–7 × 0.1–0.4 cm., whitish, cinereous, or brownish with age, villous or *velvety-pubescent,* zonate; context less than 1 mm. thick; tubes not more than 3 mm. long, the mouths white, bay, or violaceous, averaging 2–3 to a mm. in poroid

forms *but usually soon irpiciform;* spores cylindric or allantoid, hyaline, 5–6 × 1.5–2.5 μ; cystidia present or inconspicuous, hyaline, rarely incrusted at the apex, 4–5 μ in diameter, projecting 5–15 μ; hyphae of context hyaline, 4–5 μ in diameter.

On wood of *deciduous* trees.

Illustrations: Freeman, Pl. Dis. *f. 36.*—Hard, Mushrooms, *f. 345.*

Specimens examined[1]: Barth. Fung. Col. 2825, 2924 (as *Coriolus prolificans*).—Ell. N. Am. Fung. 312.—Ell. & Ev. Fung. Col. 302.—Rav. Fung. Am. 423, 108 (as *Irpex fusco-violaceus*).—Rav. Fung. Car. I, 13.—Rab.-Wint. Fung. Eur. 3331.—Shear, N. Y. Fung. 38.—Thuem. Myc. Univ. 1102 (as *P. pseudopargamenus*).—Mo. Bot. Gard. Herb. 4086 (Missouri), 4431 (Arkansas), 3855 (New York), 4443 (Indiana), 4439 (Kentucky), 4433 (Illinois), 4436 (Alabama), 4559 (Georgia), 4557 (Florida), 42875 (New Hampshire).—Burt Herb. (collections from Pennsylvania, Vermont, Kansas, and Massachusetts).—Overholts Herb. 476, 269, and others (Ohio), 1756 (Colorado).

POLYPORUS ADUSTUS WILLD. EX FRIES, P. FUMOSUS PERS. EX FRIES, P. FRAGRANS PECK, AND RELATED SPECIES

Perhaps no species have been more confused in American mycology than these three, together with a few other closely related forms both of Europe and America. They all agree in the one character of having a hymenium that usually becomes more or less smoke-colored at maturity. In *P. adustus* and its closest relatives, *P. crispus* Fries and *P. Burtii* Peck, the hymenium is usually black or grayish black from the first, while in *P. fumosus* and *P. fragrans* it frequently becomes

[1] Ell. & Ev. Fung. Col. 804, distributed as *P. pargamenus,* is *P. hirsutus* (certainly not *P. pubescens* as stated by Lloyd, Letter No. 52, p. 20). Ell. & Ev. N. Am. Fung. 1934, distributed as *P. pargamenus,* is not this species. The appearance of the plant suggests a form of *Irpex tulipifera.* I have made a microscopic study of the hymenium of the specimen and I find it has the larger incrusted cystidia of that species and not the inconspicuous cystidia of *P. pargamenus.* Mycological literature contains several names for plants closely related to, if not identical with, *Irpex tulipifera* and until the limits of the species are better known the writer hesitates to refer the above specimen with certainty.

darker in mature plants but often remains white, sometimes assuming an ochraceous tint in herbarium specimens.

Of the above-named species, the first three have been referred to *P. adustus* by Murrill. *P. adustus* was described by Willdenow[1] in 1787. *P. crispus* was first described as a species by Persoon,[2] in 1799, and was later (1815) accepted by Fries[3] and so maintained by him in his 'Hymenomycetes Europaei.' *P. Burtii* was described from Vermont by Peck,[4] in 1897, and has not since been reported. *P. fumosus* was first described by Persoon,[5] in 1801, and *P. fragrans* by Peck,[6] in 1878. There are several other names for plants closely related to, if not identical with, these species but the writer has had no opportunity to study them. One of these, *P. subcinereus,* described by Berkeley, in 1839, is said to have been repudiated by its author and the plants referred to *P. adustus. P. Halesiae* Berk. & Curt.[7] is probably distinct, and *P. Lindheimeri* Berk. & Curt.[8] is not at all related to *P. adustus,* as stated by Murrill, but is a large-pored species with a brown context.

In working over the collections referred to *P. adustus* in the herbarium of the Missouri Botanical Garden, the herbarium of Dr. E. A. Burt, and the writer's herbarium, it became evident that we are here concerned with a species that has been used as a sort of dumping-ground for all plants with a black hymenium and a rather thin context, while plants of thicker context and lighter-colored hymenium have been referred to *P. fragrans* or to *P. fumosus,* according to whether a pleasant odor was or was not noticed in the plants. Such procedure has resulted in the bringing together of a heterogeneous mass of material under the name *P. adustus.* This material was very readily separated into three fairly distinct sections besides the collections that properly belonged under

[1] Fl. Berol. p. 392. 1787.
[2] Persoon, C. H. Obs. Myc. **2**: p. 8. 1799.
[3] Fries, E. Obs. Myc. **1**: p. 127. 1815.
[4] Bul. Tor. Bot. Club **24**: p. 146. 1897.
[5] Syn. Fung. p. 530. 1801.
[6] Rept. N. Y. State Mus. **30**: p. 45. 1878.
[7] Grev. **1**: p. 52. 1872.
[8] *Ibid.* p. 50. 1872.

P. fumosus. After considerable study the writer has decided that to *P. adustus* should be referred those collections with a thin, finely tomentose pileus, a thin, even margin, and minute black pores. The species does not grow densely imbricate as in *P. crispus* (see pl. 23 fig. 7) and does not have the crisped margin of that species. The illustration of *P. adustus* given by Patouillard[1] represents our plant very well. From *P. Burtii* it is to be distinguished by the smaller and more equal pores, the thinner, sterile margin of the pileus, and the firmer context. It is much more abundant than the other three species and frequently grows semi-resupinate.

According to Fries, *P. crispus* differs from *P. adustus* in having a thin, crisped, margin and large unequal pores. One lot of segregates from my *P. adustus* material possesses just those distinguishing characters, and I have, therefore, revived the Friesian name and applied it to my plants. They are certainly distinct from the specimens referred to *P. adustus* though connected by intergrading forms to some extent. The illustrations (pl. 23 figs. 7 and 8) show typical specimens of the two species.

I have seen no specimens other than the types that could be referred to *P. Burtii.* The type specimens differ from the above conception of *P. adustus* in having a somewhat thicker context, a thicker margin that is fertile below, and larger and more unequal pores. The hymenium is black, as in that species, and the surface of the pileus is finely tomentose. The flesh of the pileus is also very soft and almost floccose in texture. It has been held by some that the mouths of the tubes in *P. adustus* become larger and more irregular in mature plants, and if such a character stood alone in the differentiation of these forms it probably should not be considered a specific character. But it is the writer's opinion that in *P. adustus* they do not become much larger in old plants, and since *P. Burtii* differs also from that species in the other characters mentioned above, we must consider it a valid species, at least until other collections throw more light on the subject. From *P. crispus* it may be separated by the fact that the

[1] Tab. Anal. Fung. *f. 142.*

margin is not crisped, sterile, and thin, that the pubescence of the pileus is not nearly so prominent, and that the context is soft and floccose. The type specimens are not densely imbricate as in *P. crispus* but more nearly approach the condition found in *P. adustus.*

The microscopic characters of these three species are identical and do not afford additional means of separating them. The tramal tissue of the pores is decidedly brown in color, the hyphae are small, and a large percentage of them are cut transversely in a cross-section of the hymenium. The spores in all three species are oblong or oblong-ellipsoid, and measure 3.5–4.5 × 1.5–2.5 μ. There are no cystidia or other sterile bodies in the hymenium.

In endeavoring to find characters on which to separate the three above-named species (and especially *P. adustus*) from specimens heretofore referred to *P. fumosus* and *P. fragrans,* recourse was had to microscopic sections of the hymenium. It was at once apparent that when longitudinal sections were prepared, according to directions given on page 678 of this paper, the tramal tissue of the tubes of *P. adustus, P. crispus,* and *P. Burtii* were decidedly brown in color, while those of *P. fumosus* and *P. fragrans* were entirely hyaline, except for the eosin stain. This character has been tested out thoroughly and is believed to be a satisfactory and constant one on which to differentiate these two groups of species. By obscuring the labels on the slides containing the sections of the different species it was found possible to easily separate the sections of the species of the one group from those of the other group by this character, and then verify the separation by uncovering the labels. Since suitable sections can be readily prepared in a very few minutes, the task of deciding between the two groups is an easy one when they cannot be readily separated on the general appearance of the specimens. Some such method of procedure is especially desirable in separating *P. adustus* from *P. fumosus,* since thin or young specimens of the latter are easily confused with the former species. However, care must be taken not to confuse the dark color sometimes obtained in thick sections of *P. fumosus* with the truly

brown color of the hyphae in *P. adustus*. In the hyphae of the latter species the color is brown, whether the sections are thick or thin. This test will usually apply to cross-sections of the tubes as well as to longitudinal sections, except that when the hymenium of a growing specimen is bruised, dried, and then sectioned, the mouths of the tubes and the hyphae at the ends of the tubes often show a brownish discoloration that may be confusing. *P. crispus* and *P. Burtii* usually are easily distinguished without this test, but the results are even more marked in the case of those two species than in *P. adustus*.

When Peck first described *P. fragrans* he stated that it was closely related to *P. fumosus,* but differed in having unequal pores and an agreeable odor. In a later report he remarked that it should perhaps be considered a variety of that species. Microscopically the two plants are the same. There are no cystidia and the spores are oblong-ellipsoid, and measure 4.5–6 × 2–3 μ, thus being slightly larger than the spores of the three species discussed above. The spore characters given for both species in the 'North American Flora' are erroneous. From our present knowledge of the variability of odors in the fungi[1] we are not warranted in laying much stress on the fragrant odor ascribed to *P. fragrans*. Bresadola[2] discusses *P. fumosus* under the name *P. imberbis* and states that the plant at times has a subanise odor. I have never obtained such an odor from plants heretofore referred to that species, but frequently the plants do have an odor that I would not describe as pleasant. In the face of such evidence, it seems reasonable to conclude that the odor alone should not separate the two species in question. As to the size and regularity of the pores of the two species, I find collections of *P. fumosus* in which the younger specimens have minute pores and the older ones have large and irregular pores, and collections of *P. fragrans* with both large and small pores. I conclude,

[1] e. g., *Polyporus graveolens* Schw. I have collected this species several times and have had growing plants under observation for three seasons and at no time have I been able to obtain the slightest trace of an odor that would warrant the application of "sweet knot" to that species. Similar results have been reported by others. There is good authority, however, for stating that it is at times very fragrant.

[2] Fung. Trid. p. 29.

therefore, that we are here dealing with a character that varies with the age of the plants or even varies in different plants of approximately the same age. In other characters the two species are identical. Bearing in mind then the following points: (1) Peck's admission concerning his species, (2) the little reliance that is to be placed on odors in at least some of the fungi, (3) the evidence that *P. fumosus* is sometimes fragrant as it grows in Europe, and (4) the variability in the size of the pores in a single collection, we can only conclude that *P. fragrans* is at most only a form of *P. fumosus* and not worthy of a distinct name.

There are a few other names that need to be mentioned before dismissing this group of species. *P. salignus* Pers. ex Fries is generally held to be *P. fumosus,* and Fries' illustration[1] certainly agrees with the species as it grows in this country. *P. Holmiensis* Fries, as distributed by Romell,[2] is surely our plant and it is so regarded by Bresadola. *P. imberbis* Bull. ex Fries, as represented by Bresadola, is the same plant, but the name was not recognized by Fries in his 'Systema Mycologici' and so cannot be used for our plant.

The following key will aid in distinguishing the four species presented here:

Pileus rather thin; hymenium black or smoky black; tramal hyphae distinctly brown in section 1

Pileus thicker; hymenium pallid to somewhat smoky; tramal hyphae hyaline or nearly so in section ..... *4. P. fumosus*

1. Pileus finely tomentose; margin thin, even, sterile below; context firm when dry; pores minute; plants slightly, if at all, imbricate ..... *1. P. adustus*

   Pileus adpressedly fibrillose on the margin, usually strigose toward the base; margin thin, crisped or wavy, sterile below; context firm when dry; pores larger and unequal; plants usually closely imbricate ..... *2. P. crispus*

   Pileus finely tomentose; margin acute but thicker than in the preceding species, even, fertile below; context soft and floccose; pores unequal; plants scarcely imbricate ..... *3. P. Burtii*

1. Polyporus adustus Willd. ex Fries. Plate 23, fig. 8.

Pilei *not much imbricate* though somewhat so at times, 1–6 × 3–8 × 0.1–0.6 cm., white to smoky white or pale tan, rarely with reddish blotches or zones, *finely tomentose to short villous-tomentose,* zonate or azonate; margin *thin, even,*

[1] Ic. Hym. 2: *pl. 181.*

[2] Fung. Scand. 11.

often black in dried specimens, sterile below; context white or pallid, firm and corky when dry, 1–4 mm. thick, in large specimens separated from the hymenium by a narrow dark line; tubes less than 2 mm. long, the mouths *grayish black to black, scarcely visible to the naked eye, averaging about 6 to a mm.;* tramal tissue decidedly *brown in color under the microscope;* spores oblong or oblong-ellipsoid, rarely slightly curved, smooth, hyaline, 3.5–5 × 1.5–2.5 μ; cystidia none.

On dead wood of deciduous trees.

Illustrations: Pat. Tab. Anal. Fung. *f. 142.*—Rostk. in Sturm's Deutsch. Fl. **3**: fasc. 16. *pl. 38.*

Specimens examined: Cooke, Fung. Brit. 2.—Ell. N. Am. Fung. 6.—Ell. & Ev. Fung. Col. 206.—Krieg. Fung. Sax. 1319.—Rabenh. Herb. Myc. 412.—Rav. Fung. Am. 421.—Shear, N. Y. Fung. 32.—Mo. Bot. Gard. Herb. 4222 (Newfoundland), 4223 (New York), 3851 (Missouri).—Burt Herb. (collections from Vermont, Ohio, Massachusetts, and New York).—Overholts Herb. 284 (Ohio), 572 (Missouri), 2239 (New York), 1780 (Colorado), and others.

2. Polyporus crispus Pers. ex Fries. Plate 23, fig. 7.

Pilei *more or less densely imbricate and overlapping,* 2–7 × 1–5 × 0.1–0.4 cm., gray to avellaneous, sometimes cinnamon to clay-colored in herbarium specimens, *adpressedly fibrillose toward the margin, usually strigose toward the base,* zonate or azonate; *margin very thin, radiate-lineate, crisped or wavy,* often becoming black, sterile below; context white or pallid, often brownish in herbarium specimens, soft and fibrous to corky, 1–3 mm. thick, usually separated from the hymenium by a narrow dark line; tubes 1–3 mm. long, the mouths *grayish black to black, unequal, irregular, averaging 3–6 to a mm.;* tramal tissue decidedly brown in color under the microscope; spores oblong or oblong-ellipsoid, smooth, hyaline, 3.5–4.5 × 1.5–2.5 μ; cystidia none.

On dead wood of deciduous trees.

Illustrations: Fl. Dan. *pl. 1850.*

Specimens examined: Romell, Fung. Sax. 8 (as *P. adustus*).—Thuem. Myc. Univ. 604 (as *P. fumosus*).—Mo. Bot.

Gard. Herb. 42868, 42848 (Arkansas), 4180 (Missouri).—Overholts Herb. 386 (Indiana), 105 (Ohio).

3. Polyporus Burtii Peck. Plate 23, fig. 4.

Pilei not closely imbricate, 1–2.5 × 2–5 × 0.3–0.5 cm., gray or pinkish buff, *finely tomentose,* azonate; margin *acute but rather thick, deflexed, even, concolorous, fertile below;* context *soft and sub-floccose* in dried plants, 2–4 mm. thick; tubes 1–2 mm. long, *the mouths grayish black to smoky black,* unequal, irregular, *averaging 2–4 to a mm.;* tramal tissue decidedly brown in color under the microscope; spores oblong-ellipsoid, smooth, hyaline, 4–4.5 × 1.5–2 μ; cystidia none.

On stump of yellow birch. Known only from the type locality, Middlebury, Vermont.

Specimens examined: Burt Herb. (type collection).

4. Polyporus fumosus Pers. ex Fries. Plate 23, fig. 3.

Pilei simple or imbricate, 2–10 × 3–15 × *0.5–2 cm.,* white to ochraceous or smoky white, sometimes stained with reddish, *finely tomentose to glabrous, sometimes with a rather broad, marginal furrow;* context white or pallid, soft corky to woody when dry, *2.5–10 mm. thick,* usually zonate, always separated from the hymenium by a narrow dark line, *anise-scented or with a disagreeable odor;* tubes 1.5–4 mm. long, the mouths *white to grayish black, usually becoming black when bruised,* averaging 3–4 to a mm.; tramal tissue hyaline or nearly so under the microscope; spores oblong-ellipsoid, smooth, hyaline, 4.5–6 × 2–3 μ; cystidia none.

On dead wood of deciduous trees, especially elm.

Illustrations: Fries, Ic. Hym. *pl. 181* (as *P. salignus*).—Bres. Fung. Trid. *pl. 135* (as *P. imberbis*).—Massee, Brit. Fung. Fl. *f. 14–15.*—Rostk. in Sturm's Deutsch. Fl. **3**: fasc. 16. *pl. 42.*

Specimens examined: Ell. & Ev. N. Am. Fung. 2902.—Shear, N. Y. Fung. 31.—Thuem. Myc. Univ. 5.—Mo. Bot. Gard. Herb. 43648 (Missouri), 4277 (Kansas).—Overholts Herb. 455, 527 (Ohio), 436 (Canada), 370 (Indiana), and others.

The White Species of Polyporus — Those Watery and Fleshy-Tough when Fresh and with White Context and Spores

This group of plants has probably been the source of more trouble and exasperation to those collecting them than any other group in the *Polyporaceae*. Collectors have sent them to various mycologists for determination, and quite often no two will agree on the name that should be applied to any one form.

The group of species with which we are here concerned has been divided into two genera by Murrill, namely, the genus *Tyromyces* and the genus *Spongipellis*. Since the characters that separate the latter from the former genus are not always well defined, it would seem better had they been united into one genus. The group includes those species found only during the summer and fall, growing on logs or on living trees, and further characterized by being white or whitish throughout, and having a more or less watery and soft fibrous context. Some of the species have characteristic odors that will usually aid in their identification. When dry the context of some of these is soft and friable, sometimes more solid, and sometimes differentiated into an upper soft portion and a lower firm portion. We cannot include here all of the species referred by Murrill to the two above-named genera, partly because there has been no opportunity to study all of them and partly because many of them are limited in their distribution and are only infrequently found by collectors. Those that are of common occurrence in the Ohio and the upper Mississippi River valleys have been studied and the results here presented. The series thus limited includes the following species: *P. albellus* Peck, *P. caesius* Schrad. ex Fries, *P. chioneus* Fries, *P. delectans* Peck, *P. fumidiceps* Atk., *P. galactinus* Berk., *P. lacteus* Fries, and *P. spumeus* Sow. ex Hornemann. These are not all closely related and most of them are not difficult to determine but they have been more or less confused in this country, and their distinguishing characters are here pointed out.

P. chioneus, P. albellus, and P. lacteus.—*P. chioneus* was described by Fries,[1] in 1815. In his 'Hymenomycetes Europaei,' published in 1874 (p. 546), he described it somewhat more fully as follows: "Albus, pileo carnoso, molli, laevigato, azono, postice saepe porrecto, margine inflexo; poris curtis, exiguis, rotundis, aequalibus, integerrimis. . . . . Ad truncos v. c. *Betulae*. . . . . unciam latus, odore acido." In 1878 Peck[2] described *P. albellus* from New York, also growing on birch. Peck evidently was not acquainted with *P. chioneus,* but he regarded his species as probably more closely related to *P. paradoxus* Fries and *P. betulinus* Bull. ex Fries. The only points of difference in the descriptions of *P. albellus* and *P. chioneus* are: (a) in size, Peck's species being described as "two to four inches broad, one to one and a half thick," and (b) in pubescence, the pileus being "smooth or sometimes slightly roughened by a slight strigose tomentum." Both descriptions mention the soft context, white color, and "acid" odor. Saccardo[3] has listed *P. albellus* as a synonym for *P. betulinus,* and while the general form and size of the two species is at times somewhat similar, it does not require close observation to distinguish them. The same cannot be said of *P. albellus* and *P. chioneus.* Murrill[4] has listed them as synonyms and the writer has expressed the same opinion in a recent paper.[5]

P. lacteus may well be brought into the discussion at this point. It was described in 1821. The description and figure[6] call for a plant similar in size and habit to *P. chioneus* but differing from that species and from *P. albellus* in having a decidedly pubescent pileus and a lacerated and labyrinthiform hymenium. These characters should be sufficient to separate at once *P. lacteus* from the other two species, and the writer can neither accept nor understand the determinations of those who would refer our common plant with a glabrous pileus and

[1] Obs. Myc. **1**: p. 125. 1815.
[2] Rept. N. Y. State Mus. **30**: p. 45. 1878.
[3] Syll. Fung. **6**: p. 139. 1888.
[4] N. Am. Fl. **9**: p. 35. 1908.
[5] Ann. Mo. Bot. Gard. **1**: p. 97. 1914.
[6] Fries, E. Ic. Hym. **2**: *pl. 182. f. 1.*

even hymenium to *P. lacteus*. Romell,[1] after a short description of *P. lacteus* as he understands it, says:

> "This species seems to be identical with one known in America as *Polyporus chioneus*. . . . . My specimens agree with the authentic specimens of *P. lacteus* at Kew. In Fries' herbarium neither *P. lacteus* nor *P. chioneus* is represented by authentic specimens as far as I know. There is, however, a collection referred to *P. chioneus* by Robert Fries, and this collection differs from my plant not only by the *glabrous surface of the pileus* but also by having the hyphae substantially *parallel and simple*. . . . . ." (Italics are the writer's.)

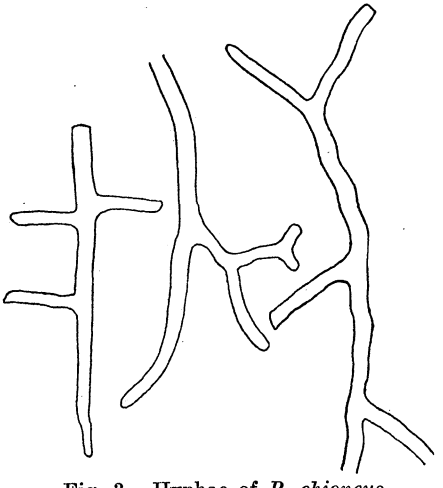


Fig. 3. Hyphae of *P. chioneus*.

It is unfortunate if, with the easy access to Fries' description, American mycologists of repute have sent specimens of a pubescent *Polyporus* to Europe under the name, *P. chioneus*. On the other hand, if the determination were that of an amateur it should not have been seriously considered by Mr. Romell. Whichever may have been the case, it is the writer's opinion that such determinations are the exceptional ones and not the rule, for the plant that is usually referred to *P. chioneus* (including *P. albellus*) is usually, if not always, entirely glabrous and has even tube mouths. In fact, it is the writer's opinion that *P. lacteus* and *P. chioneus* have been less confused in this country than in Europe. If there has been a tendency to confuse *P. lacteus* with anything it is with *P. galactinus*, as I have found several collections so misdetermined. The important point of the extract from Romell's paper is, however, that the collection to which reference is there made as having a glabrous pileus and simple hyphae in the context, in all probability represents the species that is interpreted in this paper as *P. albellus*.

Having fixed upon the distinguishing characters of *P.*

[1] Hym. Lapp. p. 15.

chioneus and accepting Fries' idea of *P. lacteus,* it becomes an easy matter to differentiate between *P. chioneus* and *P. albellus.* As stated above, and as will be seen in the accompanying illustration (fig. 4), the hyphae in the context of *P. albellus* are unbranched or at most very infrequently branched, while those of *P. chioneus* (fig. 3) are branched to a very great degree, and they vary considerably in size, some being narrow (5–6 μ) and others twice as thick. This is not the only distinguishing character, nor the one that was first hit upon by the writer, although it is probably the most reliable. The relative thinness of the pileus in proportion to its length is a distinguishing character of *P. chioneus.* In other words, the pileus is usually thin and spreading in *P. chioneus,* while in *P. albellus* it is thicker, convex or ungulate, and triangular in section. This is only a general statement of a character that varies considerably. An additional character is found in an examination of a cross-section of the hymenium, though the sections must be cut very thin to see it at its best. In sections of *P. albellus* the hyphae in the trama of the pores appear to run in all directions and give a peculiar, ever-changing appearance as they are viewed at changing foci. They are also all of one size. In *P. chioneus* the hyphae in the trama of the pores all run in one direction and practically all are cut transversely in a cross-section of the hymenium. The trama is seen to be made up of a background of a pseudocellular structure, with minute openings that indicate the cavities of the closely compacted hyphae. Interspersed over this background one sees cross-sections of hyphae two to three times larger, and standing out much more plainly than the sections of the compact hyphae in the background. It was at first thought these

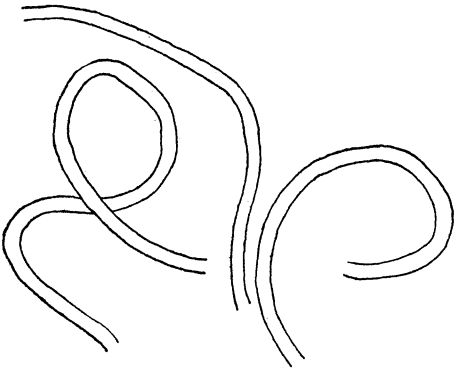


Fig. 4. Hyphae of *P. albellus.*

larger hyphae might belong to some other fungus living within the tissues of this species. This supposition is rendered improbable, however, by the fact that they are invariably present in all collections, and that while other fungi frequently attack all of these white species, their hyphae are invariably much smaller than those of the fungi attacked.

The evidence seems very clear, however, that these two species should be considered as distinct. When once differentiated they can usually be separated on the basis of their general habit, without recourse to the character of the branched or unbranched hyphae in the context, though that character can always be relied upon in establishing beyond a doubt the identity of the species. In other characters the two species are very similar. Both are glabrous or practically so; are covered with a thin grayish or yellowish pellicle that becomes more evident when the plants are dried; have a sweet acid odor when fresh, a soft and friable context when dry; and the spores are the same, being cylindric, often slightly curved, and measuring 3–4×0.7–1.5 μ. There are no cystidia.

There is considerable doubt in the writer's mind as to whether the true *P. lacteus* occurs in this country. There is a collection in the herbarium of the Missouri Botanical Garden and another in the writer's herbarium that should perhaps be referred to that species, but the hymenium has been disorganized by the growth upon it of another fungus, so that no spores are present. If future collections should show that the spores are similar to those of *P. chioneus,* the plants should in all probability be referred to *P. lacteus.* The pileus is somewhat strigose or fibrillose-pubescent, though the mouths of the tubes are not labyrinthiform. The pileus is too pubescent for either *P. chioneus* or *P. albellus* to which latter species the plants were once referred by Lloyd. It is possible that they represent *P. lacteus* as more recently defined by Lloyd.[1] I have seen no specimens so referred by him and his description of the plant as "a common white species" and again as "a frequent plant" throws some doubt on my opinion, for the plant is a rare one.

[1] Letter No. 49, p. 14.

According to the writer's notes on specimens of *P. lacteus* in the herbarium of the New York Botanical Garden, that species, as it appeared in the 'North American Flora,' is *P. albellus* as here defined, at least in part. Neither can the writer accept Romell's interpretation of *P. lacteus,* but if such a plant exists it must agree in the main with Fries' description and figure, and neither of the above interpretations do so agree. I do not know what Bresadola's latest ideas on the subject are, but at one time he regarded *P. lacteus* and *P. chioneus* as synonyms—a position just as untenable as that taken by Murrill and Romell.

According to the above interpretation of *P. chioneus* and *P. albellus,* the presentation of the two species in a recent paper[1] by the writer should be modified, and those collections that show simple hyphae in the context should be referred to *P. albellus* and those with branched hyphae should be referred to *P. chioneus.*

P. delectans and P. spumeus.—The first one of these species was described by Peck,[2] in 1884, from specimens collected in Ohio by Morgan. It is a large or medium-sized plant and was described as having a fleshy-fibrous context, a glabrous or floccose-tomentose pileus, and long tubes with large unequal mouths. By this last character and by the large size of the plant and the ellipsoid or subglobose spores it is easily distinguished from the species discussed above. In size of pores and length of tubes it is intermediate between the above species and *P. obtusus* Berk. A much more closely related species, however, is *P. spumeus.* The original notes of Sowerby on this species are very meager. The plant is described as "oozes from decaying elms in a very soft frothy mass, hardening in a day or two; and if it dries favorably, the pileus becomes hispid. The pores are small and nearly round; the tubes not long." In Sowerby's text[3] this species is followed by *P. betulinus.* Plates 211 and 212 are cited as representing the two species, respectively. Plate 211 shows a

[1] *loc. cit.* p. 97.
[2] Bul. Tor. Bot. Club 11: p. 26. 1884.
[3] Colored Figs. Eng. Fung. *pl. 211–212.* 1797–1803.

plant with a substipitate base, an incurved margin, and short tubes. One figure shows the plant from a front-underneath view, the other shows half of the plant with the cut surface outward and the hymenium upward. Plate 212 shows practically the same thing but with a little more detail, and it is a fair representation of *P. betulinus*. All later descriptions of *P. spumeus* are either based entirely on pl. 211, or else on plants that have no resemblance to the one that has since been referred to *P. spumeus*. Fries' description[1] says: "basi stipitiformi, margine incurvato."

This gives us but two alternatives from which to choose. Either Sowerby confused his illustrations of *P. spumeus* and *P. betulinus* and inserted two plates of the same species (*P. betulinus*), or else there existed at that time a plant closely related to *P. betulinus* but growing on elm and thought by Sowerby to be distinct. Since the mutual resemblance of Sowerby's two plates is so great, it is the writer's opinion that he had drawn two plates of *P. betulinus* and by mistake inserted both of them instead of one of that species and one of *P. spumeus*. This theory is borne out by the fact that he makes no mention of a stipe-like base nor an incurved margin to the plant. We may also conclude that Fries' description was drawn, in part at least, from pl. 211, for it is inconceivable that with access to Sowerby's figure he would have referred to that species a plant that departs so widely from the authentic illustration, unless he was also of the opinion that pl. 211 was a mistake.

This mistake (for so it seems we must regard it) has caused some little confusion in the literature. Fries' idea of *P. spumeus* was evidently gained, in part at least, from Sowerby's plate, for he refers as a synonym for *P. spumeus, Boletus suberosus* of Wahlenberg[2]. But Wahlenberg was aware of the existence of a *Boletus suberosus* of Linnaeus[3] and expressed the doubt that his species was the same as that one. *Boletus suberosus* of Linnaeus has always been regarded as

[1] Hym. Eur. p. 552. 1874.
[2] Fl. Upsal. p. 457. 1820.
[3] Sp. Plant. p. 1176. 1753.

a synonym for *P. betulinus*. In 1823 Hornemann[1] published a figure of *P. spumeus* entirely different from Sowerby's original figure, but in all probability a better representation of his original species. It was not, however, so accepted at the time. In the text accompanying the plates in 'Flora Danica,' Hornemann refers to Sowerby's original figure as a variety (var. *stipitatus*) of *P. spumeus*. This was evidently only a makeshift to dispose of a troublesome figure, and since the figure itself was evidently an error, Hornemann's disposition of it need have no weight. Subsequent writers did not concur in his opinion, however, and the confusion was only made worse, for now some regarded that there were two distinct plants passing under the name of *P. spumeus*. In Hooker's 'English Flora,'[2] in which the fungi were written up by Berkeley, both Hornemann's and Sowerby's illustrations are cited as representing *P. spumeus*, and Hornemann's figure is given priority in the order of citation. Again the plant is described as possessing an obsolete stipe and an incurved margin—characters either taken from Sowerby's illustration or copied from Fries. That Berkeley was in doubt as to the correctness of Sowerby's plate is evidenced by the statement: "According to Fries, the figure of Sowerby represents the species in an imperfect state. . . . . ." In 1874 Fries[3] accepted Sowerby's figure as representing *P. spumeus* and referred Hornemann's figure to *P. epileucus*. This reference was evidently followed by Saccardo. Berkeley[4] published an illustration of *P. spumeus* that corresponds well with Hornemann's figure and agrees with the plants since referred to that species. Thus there has arisen an interesting situation in which, according to the writer's interpretation, a well-known species is referred to an erroneous illustration that cannot possibly represent it, while the authentic illustration is referred to another species. Of course it is possible that Hornemann may have misinterpreted Sowerby's *P.*

[1] Fl. Dan. *pl. 1794*. 1823.
[2] Eng. Fl. 5[2]: p. 139. 1836.
[3] Hym. Eur. p. 552. 1874.
[4] Outl. Brit. Fung. *pl. 16. f. 4*. 1860.

spumeus, in which case the name should be written *P. spumeus* Hornemann, Fl. Dan. *pl. 1794.* 1823, since there is no doubt that Hornemann's figure represents *P. spumeus* as it is known in Europe to-day. But the writer prefers to accept Hornemann's plate as a correct interpretation of Sowerby's species (disregarding pl. 211) and write the name as *P. spumeus* Sow. ex Hornemann. If the writer's theory is correct, there never existed a plant, the name of which could be written as *P. spumeus* Sow. ex. Fries, Syst. Myc. **1**: 358. 1821,[1] since Fries never illustrated the plant, and his descriptions, several times repeated, were based, in part at least, on the erroneous pl. 211 of Sowerby.

In the American literature the plant was first described by the writer in a recent paper.[2] The relation of Sowerby's figure to the species was not then understood and the statement was there made that "the plants so referred do not agree with the figure given by Sowerby, nor with Fries' description." There are but few references to its occurrence in this country, although it is a fairly common species. Lloyd reports receiving it from several widely separated localities.

Whether others may agree with the writer or not, the evidence here presented should at least have the effect of doing away with the inconsistency of citing both Sowerby's illustration and that of Hornemann as representing the same species.

P. spumeus is not likely to be confused with any species except *P. delectans*. These two intergrade to some extent. The former species has a strigose-tomentose surface to the pileus while the latter is glabrous or only slightly tomentose. Heavy rains or a little handling of the plant may cause the pubescence on *P. spumeus* to become matted and appressed, but when specimens are found growing imbricated so that the lower pilei are protected by the ones above, the character is very marked. The tubes in both species are long and slender, but in *P. delectans* the mouths are larger and more sinuous, usually measuring 0.5–1 mm. in diameter, while those of *P. spumeus* are smaller, measuring about 3–4 to a mm., and col-

[1] cf. Ann. Mo. Bot. Gard. **1**: p. 99. 1914.

[2] *loc. cit.*

lapse when dry. This collapsing is due to the thinness of the dissepiments—a character easily made out in transverse sections of the hymenium. The illustration (pl. 24 fig. 14) shows the larger tubes of *P. delectans*. The spores of the two species are practically the same, varying from ellipsoid to ovoid or subglobose, and measuring 5–6×4–5 μ. They are frequently guttulate in both species. There are no cystidia in the hymenium.

P. galactinus.—This species is a fairly well-marked one and only its distinguishing features will be pointed out here. It was originally described by Berkeley from specimens collected in Ohio by Lea. It is eastern in its range in the United States, occurring from Maine to Missouri and probably no farther south than West Virginia. There are but three common plants in this section of *Polyporus* that possess characteristic odors when fresh and growing. *P. galactinus* is one of them. The odor is usually described as "acid," but to the writer it is a very pleasant and fragrant odor, but not persisting in the dried plants. Characters are not wanting to separate this species from the group just discussed in this section. The pileus is strigose-pubescent, as shown in the illustration (pl. 24 fig. 15), the tubes are very small, and the spores are minute, ellipsoid or subglobose, uninucleate, and measure 3–4 × 2–3 μ. From *P. delectans* and *P. spumeus* it may be separated by the minute pores and the smaller spores. From *P. fumidiceps* Atk. it differs in the decidedly pubescent pileus and larger size. From *P. caesius*, which it resembles in its hairy covering, it differs in its larger size and ellipsoid spores. There are no cystidia.

P. caesius.—This species has long been recognized as a well-marked one, characterized by the villous-strigose pubescence on the pileus, the bluish or grayish blue tint often present on the hymenium, and the minute, cylindric, curved spores. From *P. galactinus* it is separated by its small size and different spores; from *P. chioneus* and *P. albellus* by the pubescent pileus; from *P. lacteus* by the more strigose pileus and the unbranched hyphae of the context.

P. fumidiceps.—This species was described by Atkinson[1] in 1908, and has not since been reported. Since the writer finds it to be a rather common species in Missouri, and since a description has not appeared in the American literature, a few notes will be appended and the plant described on a following page.

In size and shape the species corresponds most closely to *P. chioneus,* but it is of a different color and the spores are ellipsoid to subglobose. From *P. galactinus* and *P. caesius* it is separated by the almost or quite glabrous pileus and from the latter also by the spores. The writer finds it most often on dead willow logs in willow thickets along river bottoms. The types were described from similar locations. Fresh plants have the same peculiar fragrant odor that is found in *P. galactinus.*

The following key will aid in the determination of the species here discussed:

Spores cylindric-oblong, often allantoid 1
Spores ellipsoid to globose 3
1. Pileus villous-strigose; hymenium often bluish or grayish blue..*5. P. caesius*
   Pileus glabrous or very slightly pubescent 2
2. Hyphae of context simple or very slightly branched; pileus usually triangular in section; tubes usually 4–9 mm. long .....*2. P. albellus*
   Hyphae of context much branched; pileus usually more applanate; tubes 1–3 mm. long .....*1. P. chioneus*
3. Spores 5–6 μ in longest direction; plants not fragrant when fresh 4
   Spores 2–4 μ in longest direction; plants fragrant when fresh 5
4. Pileus strigose-tomentose or strigose-hispid, especially on the margin; tubes collapsing on drying, the mouths equal, small, averaging 3–4 to a mm. .....*3. P. spumeus*
   Pileus glabrous or floccose-tomentose; tubes scarcely collapsing on drying, the mouths usually somewhat sinuous, averaging 1–2 to a mm. .....*4. P. delectans*
5. Pileus glabrous or nearly so .....*7. P. fumidiceps*
   Pileus conspicuously pubescent, often strigose-tomentose at the base.... .....*6. P. galactinus*

1. Polyporus chioneus Fries. Plate 24, fig. 13, 16b

Pileus soft and watery when fresh, rigid when dry, 2–7 × 1–6 × *0.5–1.5* cm., white, often grayish or yellowish when dry, glabrous or nearly so, *covered with a thin continuous gray or yellowish pellicle that becomes more evident when the plants are dried;* context white, *usually with a fragrant*

[1] Ann. Myc. 6: p. 61. 1908.

odor when fresh, soft and friable when dry, *2–7 mm. thick; tubes 1.5–3 mm. long,* the mouths white or yellowish, averaging 3–4 to a mm.; spores cylindric or allantoid, minute, hyaline, 3–4 × 0.7–1.5 μ; cystidia none; hyphae of context hyaline, much branched.

On dead wood of deciduous trees.

Specimens examined: Mo. Bot. Herb. 4311 (Missouri).—Burt Herb. (collections from Vermont and New York).—Overholts Herb. 2325, 2261, 2277, 2276 (New York), 2326 (Ohio).

2. Polyporus albellus Peck.

Plate 23, fig. 5, Plate 24, fig. 16a.

Pileus soft and watery when fresh, rigid when dry, *more or less triangular in section,* 1–8 × 1–7 × *1–4* cm., white or yellowish, glabrous or nearly so, *covered with a thin yellowish pellicle that is more evident in dried plants,* but often disappears in patches; context white, soft and friable when dry, *0.5–3 cm. thick;* tubes 4–9 mm. long, the mouths white or yellowish, averaging 3–4 to a mm.; spores cylindric or allantoid, minute, hyaline, 3–4 × 0.7–1.5 μ; cystidia none; hyphae of context hyaline, unbranched or nearly so.

On dead wood of deciduous trees.

Specimens examined: Mo. Bot. Gard. Herb. 43756 (Idaho).—Burt Herb. (collection from Pennsylvania).—Overholts Herb. 591 (Vermont), 408, 149, 207 (Ohio), 2243, 2270 (New York), 440 (Missouri).

3. Polyporus spumeus Sow. ex Hornemann.

Plate 24, figs. 10, 11, 14a.

Pileus soft and watery when fresh, rigid on drying, *5–20* × *6–20* × *2–6 cm.* (much thinner when dried), white or somewhat yellowish, *villous-strigose or matted strigose-tomentose;* context white, rigid on drying, 1–3 cm. thick; *tubes 0.5–1.5 cm. long,* collapsing when dried, the mouths white or yellowish, *averaging 2–4 to a mm.;* spores *ellipsoid to subglobose,* hyaline, smooth, often once guttulate, *5–6* × *4–5* μ; cystidia none.

Illustrations: Hornemann, in Fl. Dan. *pl. 1794.*—Berk. Outl. Brit. Fung. *pl. 16, f. 4.*

Specimens examined: Cooke, Fung. Brit. 511[1].—Thuem. Myc. Univ. 709[1].—Mo. Bot. Gard. Herb. 43719 (Missouri).—Overholts Herb. 101 (Ohio), 526, 625 (Missouri).

4. Polyporus delectans Peck. Plate 24, fig. 14b.

Pileus soft and watery when fresh, *3–15* × *5–20* × *1.5–5* cm., white, yellowish, or grayish, *glabrous to finely tomentose;* context white, often with a soft upper layer and a more firm lower layer, firm when dry, 0.5–2 cm. thick; tubes 0.5–1.5 cm. long, the mouths white or yellowish, *averaging 1–2 to a mm.; spores ellipsoid to subglobose,* often uninucleate, hyaline, smooth, *4–5* × *5–6* μ; cystidia none.

Growing from wounds of living trees and on old logs.

Illustrations: Jour. Cinc. Soc. Nat. Hist. 8: *pl. 1.*

Specimens examined: Overholts Herb. 145, 519, 250, 415, 659, 93, 258, 255 (all from Ohio and Missouri).

5. Polyporus caesius Schrad. ex Fries.

Pileus more or less triangular in outline, rather soft and watery when fresh, 1–5 × 1–4 × 0.5–2 cm., white or grayish, *rarely bluish gray, villous-pubescent or strigose;* context white, 3–10 mm. thick; tubes 3–5 mm. long, white or *grayish blue, large, unequal, averaging 1–3 to a mm., the dissepiments thin, torn and lacerated; spores cylindric or allantoid,* smooth, hyaline, *3–4* × *0.7–1.5* μ; cystidia none.

On dead wood of deciduous trees.

Illustrations: Sow. Col. Fig. Eng. Fung. *pl. 226* (as *Boletus albidus*).—Gill. Champ. Fr. *pl. 458.*

Specimens examined: Krieg. Fung. Sax. 1913.—Mo. Bot. Gard. Herb. 43650 (Missouri).—Burt Herb. (collections from Canada and New York).—Overholts Herb. 627 (Missouri), 2271 (New York).

[1] These specimens or sections of specimens are not well preserved. They contain no spores, and while the general appearance, i. e., shape of pileus, size of pores, length of tubes in comparison with thickness of context, etc., are very much the same, the context appears to be more woody and zonate than in our specimens. Ellis N. Am. Fung. 1103 is referred to *P. spumeus* Fries. It is the same as distributed by Cooke, Fung. Brit. 603, under the name *P. spumosus* Fries. There is no such species listed by Saccardo. Lloyd (Letter No. 52, p. 25) refers the Ellis specimen to *Fomes geotropus* Cooke.

6. Polyporus galactinus Berk.

Plate 24, figs. 12, 15, 17.

Pileus more or less triangular in sections, sometimes gibbous behind, rather firm but watery, 3–8 × 5–10 × 1–3 cm., white or yellowish, *strigose-tomentose at the base, short tomentose on the margin;* context fibrous when fresh, hard and *sometimes resinous when dry,* white, 0.3–2 cm. thick, *strongly zonate, with a strong fragrant odor in fresh specimens;* tubes 5–10 mm. long, the mouths white or yellowish, *minute, averaging 4–6 to a mm.;* spores *ellipsoid,* smooth, hyaline, once guttulate, minute, *3–4* × *2–3* μ; cystidia none.

On old logs in woods, especially in overflow river bottoms.

Specimens examined: Mo. Bot. Gard. Herb. 4092, 43636 (Missouri), 4138.—Overholts Herb. 42, 489, 382, 134, 252, 2178, 511, 611, 583 (mostly from Ohio and Missouri).

7. Polyporus fumidiceps Atkinson. Plate 23, fig. 6.

Pileus *thin,* soft and watery when fresh, 1–4 ×2–5 × *0.5–1* cm., vinaceous buff to avellaneous or wood-brown, *minutely pubescent or glabrous;* context white, watery, *with a strong fragrant odor, 2–5 mm. thick;* tubes 2–5 mm. long, sometimes olive-green within on drying, the mouths concolorous, *averaging 4–5 to a mm.;* spores *ellipsoid to subglobose,* smooth, hyaline, *2.5–3.5* × *1.5–2.5* μ; cystidia none.

On dead wood of deciduous trees, especially willows, in woods and along overflow river bottoms.

Specimens examined: Mo. Bot. Gard. Herb. 43712 (Missouri).—Burt Herb. (part of type collection, from New York).—Overholts Herb. 552, 2305, 2318 (Missouri).

Polyporus lucidus Leyss. ex Fries, P. Tsugae Murr., P. Curtisii Berk., and Closely Related Species

These species form a rather natural group of plants possessing the common character of a laccate or varnished pileus. *P. lucidus* was described in 1780 by Leysser (as *Boletus*) from plants collected in England. The description calls for a plant with a lateral stipe and it is so figured by English mycolo-

gists. *P. Curtisii* was described by Berkeley, in 1849,[1] from plants collected in South Carolina by Curtis. *P. Tsugae* was more recently described by Murrill[2] from plants collected in New York City on decaying trunks and stumps of *Tsuga canadensis*. *Ganoderma sessile* was described at the same time and by the same author.

In Murrill's first treatment of this section[3] *Polyporus lucidus* was reported as a synonym for *P. pseudoboletus,* the latter name being used for the plant. The species was reported as occurring in most of the states east of the Mississippi River with the exception of the New England states. *P. Curtisii* was there listed as a synonym for *P. pseudoboletus* with the remark that specimens referred to *P. Curtisii* were only variations of the other species, due to age, rapidity of growth, and perhaps to differences in the host. The next species described was *Ganoderma sessile* and that was described as differing from *G. pseudoboletus* in being annual and sessile, with a very acute margin and a more rugose surface. It was reported as occurring in Indiana, New York, Ohio, Alabama, Louisiana, and Kentucky. In the 'North American Flora,'[4] six years later, the names *Ganoderma pseudoboletus* and *Polyporus lucidus* were both entirely omitted and *P. Curtisii* was restored as a specific name. No comment was made as to why this was done, nor as to what disposition was made of the numerous collections previously referred to *Ganoderma pseudoboletus.* The writer has seen material referred to *G. sessile* by Murrill, and the supposition is that all collections, except those belonging under *Polyporus Curtisii,* were referred to his new species *Ganoderma sessile.* This supposition is borne out by the fact that the description of that species is there so amended as to include stipitate forms also, while the species as originally described was limited to sessile forms. We must also conclude that *G. sessile* was regarded by its author as distinct from *Polyporus lucidus* of Europe, else that name or an older one would have

[1] Lond. Jour. Bot. and Kew Gard. Misc. **1**: p. 101. 1849.
[2] Bul. Tor. Bot. Club **29**: p. 601. 1902.
[3] *loc. cit.*
[4] N. Am. Fl. **9**: p. 120. 1908.

been used. Mr. Murrill remarks concerning *Ganoderma sessile*[1]: "Very similar in its stipitate forms to *Polyporus lucidus* of Europe." The American plants are usually referred to *P. lucidus* by European mycologists, and taking into account the general agreement with the European descriptions and illustrations, and the fact that Murrill has consistently failed to cite any distinguishing characters upon which the legitimacy of his species might be established, we must conclude that there is no such distinction to be made between the European and the American plants. The American plant is variable in respect to the presence or absence of a stipe, and that cannot enter into the discussion.

There is a tendency among mycologists[2] to disregard the *Ganoderma Tsugae* described by Murrill. To the writer this species appears to be a perfectly good one, although it cannot be differentiated on host character alone. A further discussion of this species is reserved for a following paragraph.

In 1908 Atkinson[3] described a species of *Ganoderma* which he called *G. subperforatum.* After an examination of the type specimens the writer referred[4] this species to *Polyporus lucidus.* This leaves us three species of this section of *Polyporus* that are found in the central states. There are no spore characters of sufficient importance or constancy that can be used in separating them. There is a color difference but it probably cannot always be relied upon. The pileus of *P. Tsugae* is shining and mahogany-colored or darker; that of *P. lucidus* is of a lighter red color; and that of *P. Curtisii* is yellowish, at least in mature plants. Moreover, *P. Curtisii* is southern in its distribution, not being found north of the Ohio River; *P. Tsugae* is not reported south of Virginia; and *P. lucidus* is not limited in its north and south distribution in the United States.

[1] Northern Polypores, p. 55. 1914.

[2] cf. Atkinson, Bot. Gaz. **46**: p. 335. 1908. *G. Tsugae* is here listed as a synonym for *G. pseudoboletus* (=*P. lucidus*). Later on the same page it is given varietal rank; also Lloyd (Letter No. 52, p. 27) cites it as a synonym for *Fomes lucidus.*

[3] Bot. Gaz. **46**: p. 337. 1908.

[4] *loc. cit.* p. 123.

A more constant difference that serves to separate *P. Tsugae* is the color of the context. In *P. lucidus* and *P. Curtisii* the context is never pure white, but is usually separated into an upper light-colored and a lower brown layer. This lower layer is more firm than the upper one and often contains horny fibers. In *P. Tsugae* the context is uniform in texture and almost pure white throughout, but often with a very slight tinge of brown next the tubes. Under the microscope this effect is magnified. There are no brown hyphae in the context of *P. Tsugae,* while in the other two species brown hyphae are very pronounced, especially in the layer of context next the tubes. A comparison of the size of the hyphae in the three species is interesting but does not always give conclusive evidence as to the identity of the species. The hyphae of *P. Curtisii* vary from 4 to 6 μ in diameter. Those of *P. lucidus* are more variable. In some cases they cannot be differentiated from those of *P. Curtisii* in point of size, but in some specimens they attain a diameter of 10 μ. Those of *P. Tsugae* often attain a diameter of 15 μ. The difference in the branching of the hyphae of these three species is very striking and is shown in figs. 5 and 6, all drawn to the same scale. Figure 5a represents the hyphae of *P. Curtisii,* which are not extremely branched but can by no means be said to be unbranched. Figure 5b shows the hyphae of *P. lucidus,* and the branching does not differ materially from that of *P. Curtisii.* In both species the large hyphae may extend more than across the field of the high-power microscope and not branch at all in that distance. This condition is never found in the hyphae of *P. Tsugae.* There the hyphae are extremely branched, as shown in fig. 6. The large hyaline

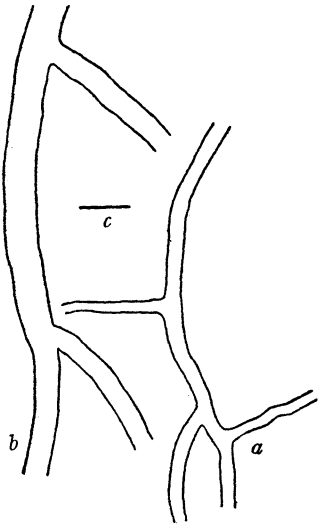


Fig. 5. *a,* hyphae of *P. Curtisii; b,* hyphae of *P. lucidus; c,* width of hyphae of *P. Tsugae.*

hyphae are not continuous for any distance but break up into numerous smaller branches that are often rapidly narrowed to fine thread-like hyphae. This condition must be seen to be best appreciated. It affords, however, another character on which the species can be separated from those closely allied.

The following brief diagnoses of these species is appended:

1. Polyporus Curtisii Berk.

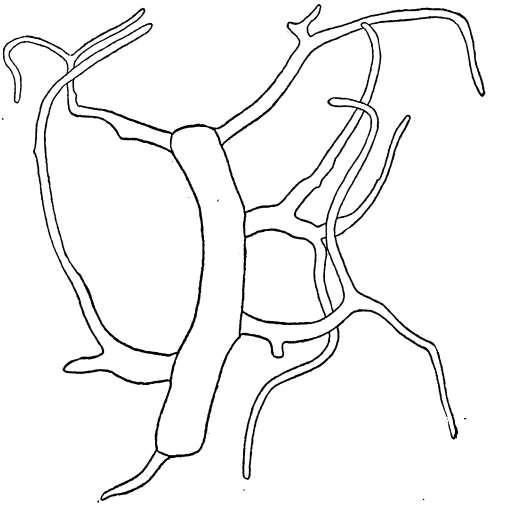


Fig. 6. Hyphae of *P. Tsugae.*

Plants perhaps always stipitate; pileus reniform or flabelliform, 3–12 × 3–20 × 0.7–2 cm., covered with a thin crust that is *at least in part ochraceous in mature plants,* zonate; context *soft and nearly white above, brown and firmer next the tubes,* 0.5–1.5 cm. thick; tubes 0.3–1.2 cm. long, the mouths white to brownish, averaging 3–5 to a mm.; stipe lateral, with color and context as in the pileus; spores light brown, ovoid with a truncate base, apparently echinulate, 8.5–11.5 × 4.5–7 μ; cystidia none; hyphae of context hyaline or brown, *4–6 μ in diameter.*

On and about trunks of *deciduous* trees.

Illustrations: Bot. Gaz. **46**: *f. 1–3.*

Specimens examined: Ell. N. Am. Fung. 802.—Rab.-Wint. Fung. Eur. 3430.—Mo. Bot. Gard. Herb. 1438 (Louisiana), 4746 (Alabama).—Overholts Herb. 305 (Florida), 962, 518 (Missouri), 2235 (New York). Also reported from most of the other states east of the Mississippi and south of the Ohio Rivers.

2. Polyporus lucidus Leyss. ex Fries.

Plants sessile or stipitate; pileus dimidiate or reniform, 3–12 × 3.5–20 × 0.5–2.5 cm., covered with a thin *reddish or*

chestnut crust, zonate; context white to light brown, *usually separated into an upper light-colored layer and a lower brown layer, never entirely white,* 0.2–1.5 cm. thick; tubes 0.3–1.5 cm. long, the mouths white to umber, averaging 3–5 to a mm.; stipe lateral or excentric when present, with color and context as in the pileus; spores light brown, ovoid with a truncate base, smooth or appearing echinulate, 9.5–11 × 5–6.5 μ; cystidia none; hyphae of context hyaline or brown, branched, *4–10 μ in diameter.*

On and about stumps and trunks of *deciduous* trees.

Illustrations: Bot. Gaz. **46**: *f. 5.*—Dufour, Atlas Champ. *pl. 49. f. 116.*—Gill. Champ. Fr. *pl. 457.*—Hard, Mushrooms, *f. 332.*—Krombh. Abbild. u. Beschr. *pl. 4. f. 22–24.*—Rostk. in Sturm's Deutsch. Fl. **3**: fasc. 5. *pl. 13.*

Specimens examined: Ell. N. Am. Fung. 5.—Ell. & Ev. Fung. Col. 202 (Delaware).—Krieg. Fung. Sax. 1116.—Rav. Fung. Am. 5.—Thuem. Myc. Univ. 104.—Mo. Bot. Gard. Herb. 43149, 4095, 4024, 4144 (Missouri), 43939 (Illinois).—Burt Herb. (collection from Vermont).—Overholts Herb. (collections from New York, Florida, Ohio, Illinois, and Missouri).

3. Polyporus Tsugae Murrill ex Overholts n. comb.

Plants stipitate; pileus flabelliform or reniform, 5–15 × 7–20 × 1–4 cm., with a *mahogany-colored or almost black, shining,* incrusted surface, sulcate; context *white or nearly so throughout,* 0.5–2 cm. thick; tubes 0.5–1 cm. long, the mouths white to brown, averaging 4–6 to a mm.; stipe present, with color and context as in the pileus; spores light brown, ovoid with a truncate base, apparently echinulate, 9–11 × 6–7 μ; cystidia none; *hyphae of context very irregular and much branched, up to 15 μ in diameter.*

On or about stumps and trunks of *hemlock and pine.*

Specimens examined: Burt Herb. (collection from Vermont).—Overholts Herb. 2338 (Vermont).

Fomes Ellisianus And. and F. fraxinophilus Peck

Fomes fraxinophilus was described by Peck from New York in 1882. It was first described as a *Polyporus* and later trans-

ferred to the genus *Fomes*. *F. Ellisianus* was described from Montana by Anderson in 1891, and redescribed as *Polyporus circumstans* by Morgan from South Dakota in 1895. The former species is abundant in the central and eastern United States, growing only on the trunks of ash trees. The latter species is found occasionally in the western United States, growing only on trunks of *Shepherdia*.

Lloyd has recently expressed the opinion that these two species are identical, except for host, and he has so treated them in his recent synopsis of the genus *Fomes*. The plants are much alike in their old stages but I cannot agree with him that *Fomes Ellisianus* is "*exactly the same plant*" as our eastern species on the ash. First, there is the distinction in host, but that of itself would not be important. Second, plants of *F. Ellisianus* that are fairly mature have a decidedly corrugated or radiate-rugose surface and a reddish tinge of color. I have seen no indication of either of these characters in *F. fraxinophilus* though I have been familiar with that species for a number of years and have observed it in all stages of growth. When the plants are several years old they become similar in appearance and it would be an easy matter to mistake the one for the other if the host were unknown. But the characters pointed out here are believed to be amply sufficient for retaining the two plants as distinct species.

The following brief descriptions are appended:

1. Fomes Ellisianus Anderson.

Pileus convex to ungulate, 3–10 × 3–8 × 1.5–4 cm., pallid to brown, *radiate-rugose and with a reddish tinge when young, black and usually somewhat rimose with age,* sulcate; context pallid to wood-colored, punky to corky, 0.5–2 cm. thick; tubes 2–6 mm. long each season,[1] *not distinctly stratified,* the mouths white or yellowish, *averaging 2–3 per mm.;* spores oblong-ellipsoid to broadly ellipsoid, 6–8 × 4–5 μ; cystidia none; hyphae hyaline, 3–5 μ.

On Shepherdia in the west-central states.

[1] The tubes in this plant are sometimes continuous to a length of 1.5 cm., but I do not believe that such lengths are attained in a single year's growth.

Illustrations: Bot. Gaz. **16**: *pl. 12.*—Jour. Cinc. Soc. Nat. Hist. **18**: *pl. 1. f. 4* (as *P. circumstans* Morg.).

Specimens examined: Anderson, Paras. Fung. Mont. 537 (as *P. fraxinophilus*).—Baker, Pl. N. N. Mex. 55.—Mo. Bot. Gard. Herb. 4272 (New Mexico).—Burt Herb. (collections from Montana and New Mexico). Also reported from North Dakota and Colorado.

2. Fomes fraxinophilus Peck.

Pileus convex to somewhat ungulate, 2–25 × 3.5–40 × 1.5–10 cm., *at first white,* soon grayish black or black, *not rugose, somewhat rimose* with age, sometimes sulcate; context woody, 0.5–1.5 cm. thick; tubes 2–4 mm. long each season, *indistinctly stratified,* the mouths white to brownish, *averaging 2–3 to a mm.;* spores ellipsoid to ovoid, 5–6 × 6–7 μ; cystidia none; hyphae 3–5 μ.

On living or dead ash trees.

Illustrations: U. S. Dept. Agr., Bur. Pl. Ind. Bul. 32: *pl. 2.*—Hard, Mushrooms, *f. 350.*

Specimens examined: Ell. & Ev. N. Am. Fung. 3302 (Kansas); Fung. Col. 909 (Kansas).—Mo. Bot. Gard. Herb. 4780, 1437, 4826 (Missouri).—Burt Herb. (collections from Kansas).—Overholts Herb. 46, 157, 159, 122, etc. (Ohio), 559, 624 (Missouri), 626 (Iowa). Also reported from Kentucky, Nebraska, Pennsylvania, Indiana, and New York.

FOMES IGNIARIUS LINN. EX GILLET AND F. NIGRICANS FRIES

Much confusion has existed concerning the limits of these two species, and many different ideas are stated in the literature. Murrill has referred *Fomes nigricans* as a synonym for *F. igniarius.* Lloyd has kept them apart, though recognizing a close relationship between them. Others have concluded with Bresadola that we are here dealing with two species that can be easily separated on the presence or absence of setae in the hymenium. Romell has held that such is not the case, but that setae may be present or rare in either species, and has stated that they are usually most abundant near the bottom of the tubes. This would account for the fact that some

observers have stated that they have been unable to find setae in the hymenium of *F. nigricans*.

The original illustration of *F. nigricans* does not agree with any present-day conception of what the species really was. The manner in which the plates for Fries' 'Icones' were gotten together does not at all preclude the existence of grave errors regarding the identity of the species there illustrated. Hence the original illustration of *F. nigricans* has been discounted by careful European workers, they preferring to base the species rather on specimens authenticated by Fries himself. Of these, there appear to be specimens both at Upsala and at Kew.

The *F. nigricans* of my 'Ohio Polyporaceae' proves to be *F. Bakeri* Murrill. The specimens referred by me to *F. igniarius* are of two types. One of these has the pileus convex or ungulate, the surface sometimes becoming rimose, and setae not at all abundant. The second type is most commonly found on birch trees. The pileus is plane or slightly convex, sometimes shining black in color, and the surface often cracks in both directions but does not become roughly rimose. The setae are often more abundant. Of this second form, Lloyd recently wrote as follows concerning a collection sent to him by me: "It agrees with his (Fries') specimens (of *F. nigricans*) both at Upsala and at Kew. . . . . It is usually thinner than typical *F. igniarius* and the setae are more abundant than in the type form."

On the strength of this information I am now able to separate my collections of these forms into what I am convinced are the two species, *F. igniarius* and *F. nigricans,* respectively. I have examined all available material of the two species and have thoroughly confirmed Romell's observation on the presence of the setae. In but one collection was I unable to find setae and I do not doubt that further attempts would show their presence in that instance. It is advisable, however, as stated on a previous page of this article, to cut *longitudinal* sections of the hymenium, since by so doing one will be more likely to strike the setae if there is any variation in their abundance at particular places in the tubes.

The characters cited above do not appear to the writer to be sufficient to warrant the complete separation of the two species. They are sufficiently distinct, however, to enable one to refer to one form or the other all the specimens collected. It has been thought best to refer *F. nigricans* as a variety of *F. igniarius.*

The following diagnosis of the species and its variety is appended:

1. **Fomes igniarius** Linn. ex Fries.

Typical form: Pileus *convex or ungulate,* 3–10 × 5–20 × 2–10 cm., grayish black or black, *rarely roughly rimose with age,* not incrusted; context hard and woody, brown, 0.5–1 cm. thick; tubes 2–5 mm. long each season, the older layers conspicuously white-stuffed or incrusted, the mouths brown, averaging 4–5 per mm.; spores globose or subglobose, smooth, hyaline, 4–6 μ; setae present though sometimes rare, sharp-pointed, 16–25 × 6–8 μ; hyphae 3–4 μ.

Var. *nigricans* Fries: Pileus *plane to convex,* 3–10 × 3–15 × 2–7 cm., black, *sometimes shining black, the surface often cracked in both directions but never roughly rimose;* context and tubes as in the typical form, decidedly white incrusted; spores, setae, and hyphae as above, the setae often abundant.

On trunks of living deciduous trees.

Illustrations: Published illustrations passing under the name of this species and its variety are abundant, but typical representations of my plants so referred are scarce. The type form intergrades into the variety to such an extent that some illustrations are hard to refer. The typical form is represented by Hard, Mushrooms, *f. 349,* and in *pl. 25. f. 18.* of this paper. The variety is well represented by Lloyd, Myc. Notes 29: *f. 193;* Rostkovius in Sturm's Deutsch. Fl. **3**: fasc. 17. *pl. 51.*

Specimens examined[1]: Ell. & Ev. N. Am. Fung. 915 (Kentucky).—Krieg. Fung. Sax. 526.—Thuem. Myc. Univ. 105.—Mo. Bot. Gard. Herb. 4037* (New York), 4043* (New York),

[1] Collections assigned to var. *nigricans* are marked with an asterisk.

43627* (Vermont), 42958 (Florida).—Burt Herb. (collections from Vermont and Canada).—Overholts Herb. 378* (Indiana), 423 (Ohio), 2460* (Vermont), 2256 (New York), 450 (Missouri).

FOMES SCUTELLATUS SCHW. EX COOKE AND F. OHIENSIS BERK. EX MURRILL

These two species are closely related and have on more than one occasion been treated as a single species. *Fomes scutellatus* was first collected by Schweinitz on dead *Syringa* in Pennsylvania. It has since been reported on a few other hosts, namely, alder, witch-hazel, and sweet-gum. *F. ohiensis* was originally described from Ohio by Berkeley and is a very common species in that state. It is especially abundant on dead limbs on the ground in woods in September and October. Quite frequently it grows on fence posts, pickets, and a variety of other structural timbers. Both species were formerly frequently referred to the genus *Trametes,* but it seems best to restrict that genus to annual forms only.

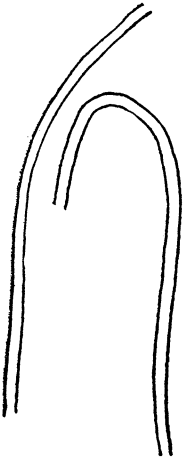


Fig. 7. Hyphae of *F. ohiensis.*

Besides the host distinction, other characters may be used to distinguish between the two species. In typical specimens of *F. scutellatus* the pileus is entirely black and attached dorsally to the under side of branches. *F. ohiensis* is rarely found so attached, and the whole plant is at first white, the upper or basal part of the pileus becoming blackish with age, as in many species of *Fomes,* but the margin remaining white, even in perennial forms. *F. scutellatus* is rarely ungulate in form, while old specimens of *F. ohiensis* become steep in front, much as in *F. fomentarius.*

The spores of *F. scutellatus* have never been recorded and Lloyd has recently stated[1] that he has failed to find them even in freshly collected material. Murrill records them as

[1] Syn. Fomes, p. 218. 1915.

"smooth, hyaline," but that conclusion is reached only from inference. I find them to be cylindric, hyaline, smooth, 8–9 × 2.5–3.5 μ. They thus differ from those of *F. ohiensis,* which are ovoid with a truncate base, hyaline, smooth, 10–12 × 6–7 μ. It is apparent then that the spores of *F. ohiensis* are similar in shape to those found in all species recently segregated into the genus *Ganoderma,* while those of *F. scutellatus* point to an alliance of that species with the genus *Trametes,* they being typical trametoid spores.

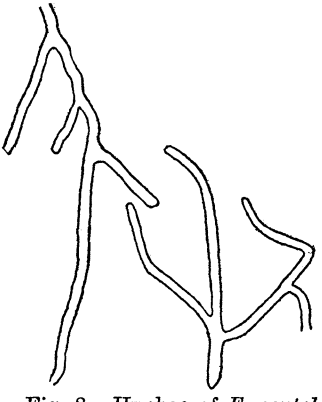


Fig. 8. Hyphae of *F. scutellatus.*

It is only in rare cases that the branching of the hyphae of the context can be used as a distinguishing character. The hyphae of *F. scutellatus* are much branched, while those of *F. ohiensis* are practically simple. These differences are shown in figs. 7 and 8.

It is thus apparent that these closely related species are separated by rather wide differences, and their determination need no longer be considered difficult.

The following descriptions are appended:

1. **Fomes scutellatus** Schw. ex Cooke.

Pileus *convex,* sometimes attached by the vertex and circular in outline, 0.5–1.5 × 0.5–2 × 0.1–0.5 cm., *entirely dark brown or black,* at least when mature, slightly sulcate; context corky, about 2 mm. thick; tubes 1–2 mm. long, the mouths white or pallid, averaging 4–5 per mm., thick-walled; spores *cylindric, 8–9 × 2.5–3.5 μ;* cystidia none; hyphae hyaline to light brown, *much branched,* 2–4 μ; basidia 6–9 μ broad.

Usually growing on alder and witch-hazel.

Specimens examined: Ell. & Ev. N. Am. Fung. 1597 (Pennsylvania); Fung. Col. 1010 (Vermont).—Mo. Bot. Gard. Herb. 4469 (New Jersey).—Burt Herb. (collections from New York and Vermont).—Overholts Herb. 337 (Ohio), 2394 (Florida). Also reported from Maine, Delaware, and Alabama.

2. Fomes ohiensis Berk. ex Murrill.

Pileus *convex to ungulate,* sometimes attached by the vertex and circular in outline, 0.5–2.5 × 0.5–3 × 0.2–1 cm., *pure white, then black at the base, the margin remaining white,* often zonate or sulcate; context corky or woody, 1–3 mm. thick; tubes 1–4 mm. long, the mouths white, averaging 3–5 per mm., thick-walled; spores[1] *ovoid with a truncate base, 10–12 × 6–7 μ*; cystidia none; hyphae hyaline, *unbranched,* 3–4 μ; basidia 8–11 μ broad.

On dead wood and on structural timbers.

Specimens examined: Ell. N. Am. Fung. 923 (as *Trametes*) (Ohio).—Burt Herb. (collection from South America, ex Herb. Romell).—Overholts Herb. 38, 39, 131, and others (Ohio), 479 (Missouri), 503 (Illinois). Also reported from Kansas, Michigan, and New York.

Trametes Pini Thor. ex Fries, T. Abietis Karst., and T. piceinus Peck.

Trametes Pini dates from the year 1803, when it was described by Thore,[2] and again in the following year, 1804, by Broteri.[3] The typical form of the perennial plant is rather large, has a more or less ungulate pileus, and in age becomes blackish and rimose. At times, however, the first year's growth is thin and applanate and thus differs markedly in form from the typical plant. This condition was observed by Peck and the name *Polyporus* (later changed to *Trametes*) *piceinus* was proposed by him for the form that he collected on *Picea* about 1889.[4] Karsten had already[5] described the same plant in Europe, in 1882, as *Fomes Abietis,* and the two names have been used interchangeably in this country for several years. In 1889 Karsten[6] referred to his species as

[1] According to Murrill (N. Am. Flora **9**: p. 96. 1908) the spores of the size and form given here are conidial, but they represent the only type of spore I have been able to find in the hymenium of this species.

[2] Chlor. Land. p. 487. 1803.

[3] Fl. Lusit **2**: p. 468. 1804.

[4] Rept. N. Y. State Mus. **42**: p. 121. 1889.

[5] Bidrag Finl. Nat. Folk. **37**: p. 242. 1882.

[6] Finl. Basidav, p. 336. 1889.

Trametes Pini var. *Abietis,* and that name has also appeared in the American literature. The writer has not seen Karsten's types and his opinion as to the synonymy of the species of Peck and Karsten is based entirely on the use of the names in this country and on the fact that *T. Pini* var. *Abietis,* as distributed by Romell,[1] is certainly to be referred to Peck's species. In the case of *Polyporus piceinus* and *Trametes Pini,* however, the evidence is not so clear, and there are yet mycologists who distinguish between the two species.

Peck has stated[2] that the pileus of *T. piceinus* is persistently tomentose, while that of *T. Pini* is not tomentose, and on this ground and also in view of the fact that the former is thin and applanate while the latter is thick and ungulate, the two have been kept apart to some extent, though Murrill, in 1908, declared them to be not specifically distinct. During the summer of 1913 and again in 1914 the writer had the privilege of collecting in the almost unexplored (mycologically) region of the Rocky Mountains in central Colorado. Here the forests are principally composed of the lodge-pole pine (*Pinus Murrayana*) and the Engelmann spruce (*Picea Engelmannii*), the former genus being the typical host of *T. Pini* and the latter the same for *T. piceinus.* No extensive field observations had been previously reported as to the intermingling of these supposed species of fungi, and the opportunity was taken to procure some notes on the subject. In that region the species is more abundant on the spruce than on the pine, probably because the best spruce forests follow the courses of the streams, while the pine often represents the only tree growth on the mountain sides and in the higher parts of the mountain parks where the soil often contains a higher percentage of sand. Such forests are not dense and quickly become dry, unless kept moist by daily rainfalls. Hence the statement that *T. Pini* is more often found on spruce in that locality is not surprising. In one instance in an area of no more than four square feet on a spruce snag the writer counted 18 sporophores, and of these about half were the *T. Pini* form and

[1] Fung. Scand. 7.

[2] Rept. N. Y. State Mus. 54: p. 170. 1901.

the rest were good specimens of the thin form known as *T. piceinus*. There is no doubt in the writer's mind that all these sporophores came from a common mycelium. In 1914 a similar find was made, the substratum being an old spruce log. Portions of these two collections are preserved in the writer's herbarium. Attempts were later made to separate the specimens in these collections by means of microscopic characters, but it was found to be impossible. In view of these observations it is seen that the recently expressed opinion of Meinecke[1] that the variation in shape is due to the host, is not true for the fungus, as it sometimes occurs in Colorado.

In some localities it may be more convenient to consider the thin form as a variety of *T. Pini*, for it must be admitted that the two forms do not always grow in such close association as described above. Yet the evidence is clear that they cannot be regarded as distinct species.

The writer believes that it will add to the clearness of the general situation in the *Polyporaceae* to include in the genus *Fomes* all perennial plants of whatever structure. This not only simplifies the definition of the genus *Fomes*, but also gives a clearer idea of the genus *Trametes*. As it has been commonly understood, the genus *Trametes* is a very poorly defined one, and any attempt to make its limits clearer is a step in the right direction. The transfer of this species to *Fomes* has already been made by Lloyd[2]. The species is here described under that name.

1. **Fomes Pini** Thor. ex Lloyd.

Sporophores very variable, the variations grouping themselves as follows:

Typical form: Sporophore *perennial, often ungulate, 6–15* × *4–20* × *1–15* cm., at first tawny and with elevated zones of appressed tomentum, becoming blackish and glabrous, the surface cracking or becoming rough and irregular; context not more than 5 mm. thick, tawny or ochraceous tawny, woody; tubes 2–6 mm. long each season, the mouths ochraceous to

[1] Forest tree diseases common in California and Nevada, p. 43. 1914.

[2] Syn. Fomes, p. 275. 1915.

brown; spores globose or subglobose, hyaline, 4–5 μ broad; setae abundant, sharp-pointed, brown, extending 20–30 μ beyond the basidia; hyphae 3–5 μ.

Var. *Abietis* Karsten: Sporophores *usually annual, rather thin and applanate, 1–5* × *1–7* × *0.3–1* cm., tawny or russet-tawny toward the margin, the immediate margin sometimes brighter-colored, zonate with elevated ridges of tomentum, grayish black or brownish black toward the base; context colored as in the typical form, 1–3 mm. thick; tubes *usually in a single layer;* spores, setae, and hyphae, as in the typical form.

On wood of coniferous trees, both living and dead.

Illustrations: Boudier, Ic. Myc. *pl. 161.*—Delacroix, Atlas Path. Veget. *pl. 19. f. 10–12.*—Meinecke, For. Tree Dis. Calif. and Nev. *pl. 4–5.*—Rostk. in Sturm's Deutsch. Fl. **3**: fasc. 17. *pl. 50.*

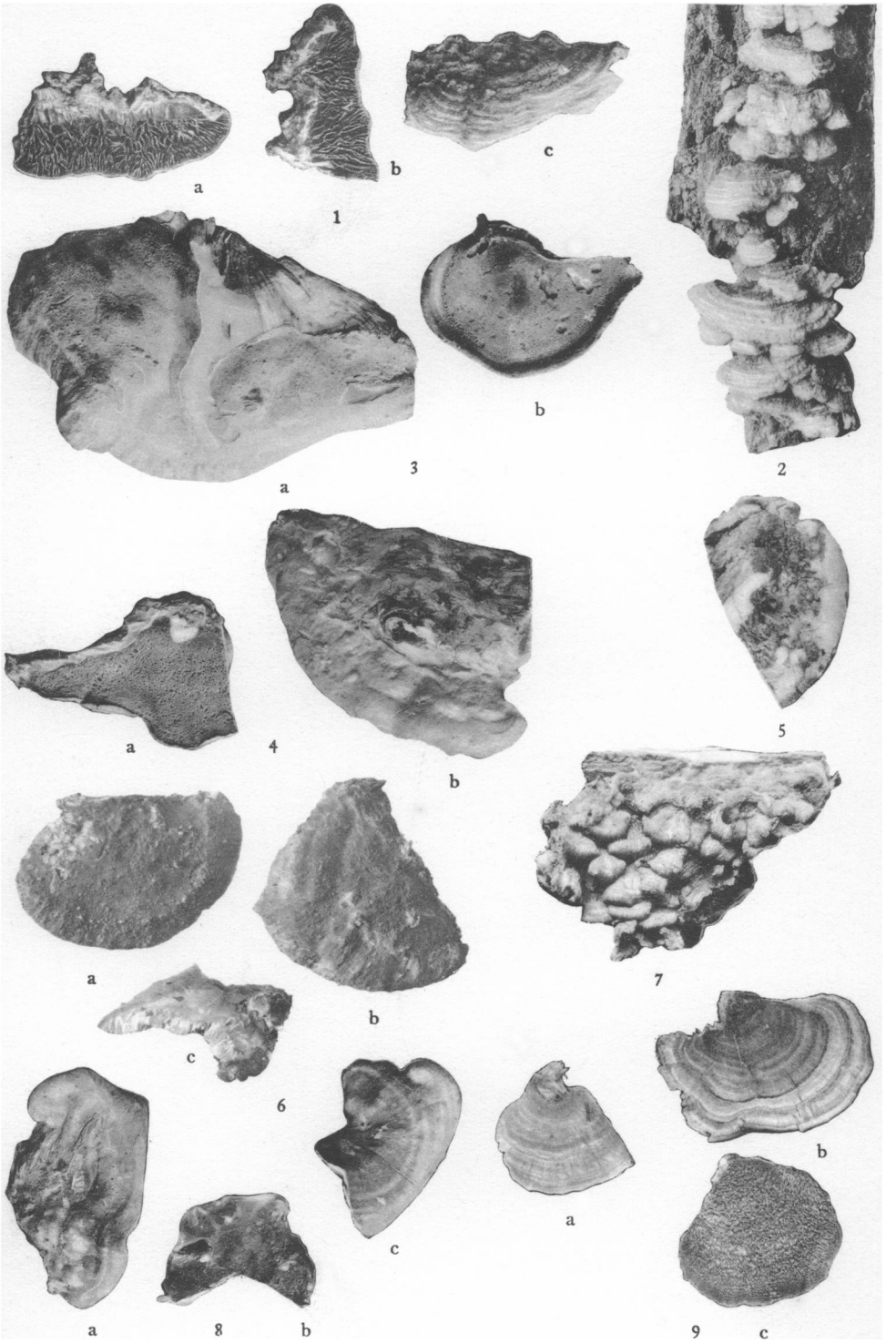
Specimens examined: Ell. N. Am. Fung. 602 (New Jersey).—Ell. & Ev. N. Am. Fung. 2507 (as *T. Abietis*) (Canada).—Linh. Fung. Hung. 348.—Rabenh. Crypt. Samm. Schule & Haus 8; Herb. Myc. 118.—Romell, Fung. Scand. 7 (as *T. Pini* var. *Abietis.*—Seym. & Earle, Econ. Fung. **11**: 549.—Mo. Bot. Gard. Herb. 42958 (Washington), 4609 (Newfoundland), 42970 (Maine), 42954 (Michigan), 42956 (Vermont), 4618 (Colorado), 43810 (Missouri), and others.—Overholts Herb. 154 (Ohio), 630, 2033, 642, and 2391 (Colorado), 2458 (Montana), and others.

Graduate Laboratory, Missouri Botanical Garden.

EXPLANATION OF PLATE

PLATE 23

Fig. 1. Specimens of *P. abietinus* with lamellate hymenium.
Fig. 2. Surface view of typical sporophores of *P. abietinus*.
Fig. 3. Typical sporophores of *P. fumosus*.
Fig. 4. *P. Burtii*. Photograph of type specimens.
Fig. 5. Upper surface of *P. albellus*.
Fig. 6. *P. fumidiceps*, showing upper surface and section through a sporophore.
Fig. 7. *P. crispus*, showing the densely imbricate mode of growth and the pubescent pileus.
Fig. 8. *P. adustus*. View of surface of pileus and hymenium.
Fig. 9. Typical sporophores of *P. pargamenus*.



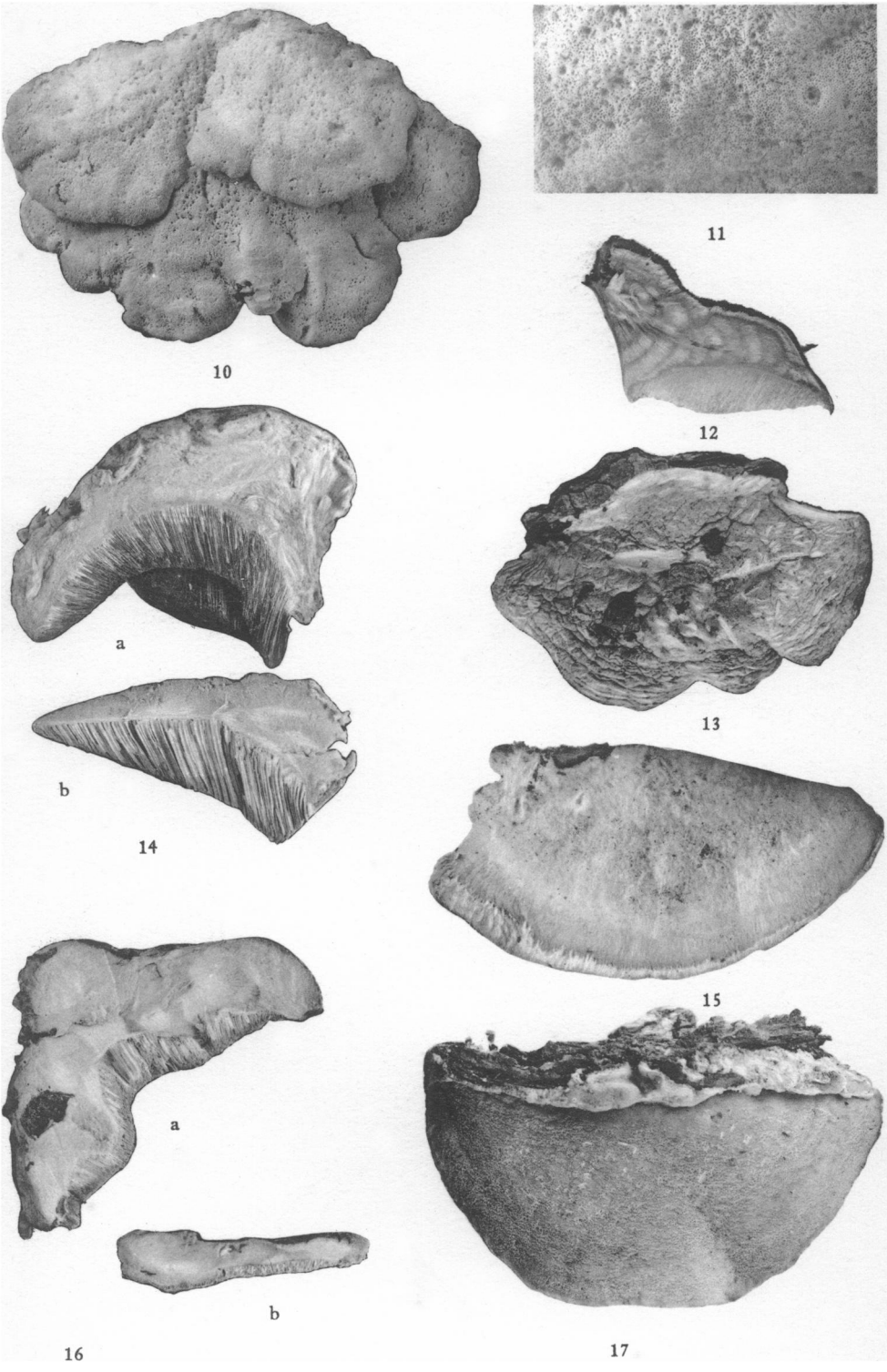
OVERHOLTS—POLYPORACEAE

COCKAYNE, BOSTON.

EXPLANATION OF PLATE

PLATE 24

Fig. 10. View of hymenium of *P. spumeus*.
Fig. 11. The pores of *P. spumeus* somewhat enlarged.
Fig. 12. Section through a sporophore of *P. galactinus*. Note the prominent zonation of the context.
Fig. 13. Upper surface of *P. chioneus*.
Fig. 14. Comparison of the size of the tubes in (a) *P. spumeus* and (b) *P. delectans*.
Fig. 15. Upper surface of *P. galactinus*. Note the prominent pubescence.
Fig. 16. Sections showing the relative thickness of the pilei in (a) *P. albellus* and (b) *P. chioneus*.
Fig. 17. Hymenium of *P. galactinus*.



OVERHOLTS—POLYPORACEAE

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EXPLANATION OF PLATE

PLATE 25

Fig. 18. Sporophore of *F. igniarius* growing on beech trunk.

Fig. 19. View of upper surface and section through a sporophore of *F. fraxinophilus.*

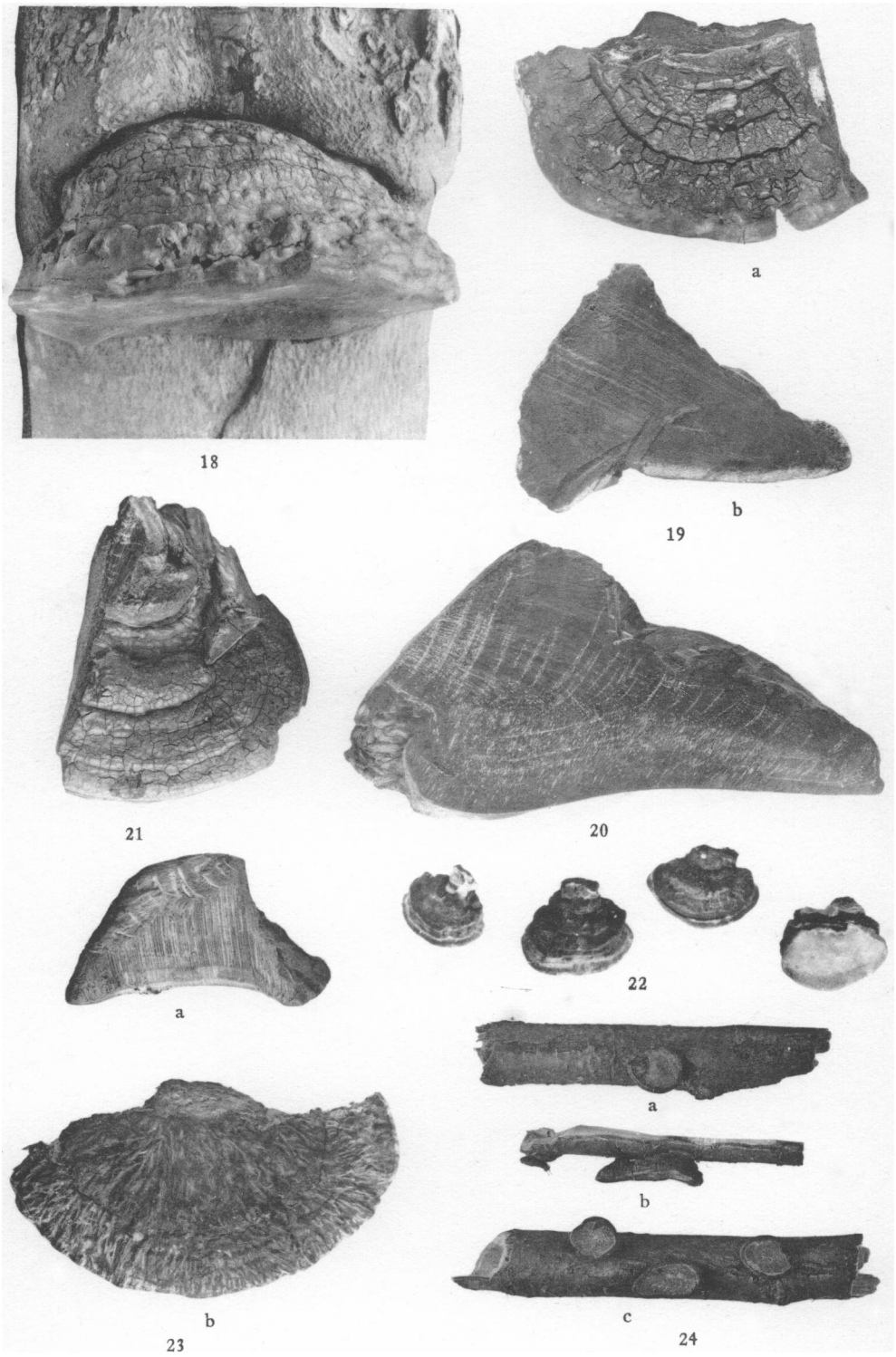
Fig. 20. Section through a typical sporophore of *F. igniarius* var. *nigricans.* Note the strongly white incrusted layers of tubes and context.

Fig. 21. Surface view of the same specimen of *F. igniarius* var. *nigricans.*

Fig. 22. Sporophores of *F. ohiensis.*

Fig. 23. *F. Ellisianus,* showing rugose upper surface and section of hymenium with long tubes.

Fig. 24. Sporophores of *F. scutellatus* on limbs of alder.



OVERHOLTS—POLYPORACEAE

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